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Ins. Mats.	Insecta Matsumurana
Jap. Jour. Genetics	Japanese Journal of Genetics
Jap. Jour. Limnol.	Japanese Journal of Limnology
Jour. Biochem.	Journal of Biochemistry
Jour. Fac. Sci., Hokkaido Imp. Univ.	Journal of Faculty of Science, Hokkaido Imperial University
Jour. Hokkaido Forest Soc.	Journal of Hokkaido Forest Society
Mem. Coll. Sci., Kyoto Imp. Univ.	Memoirs of the College of Science, Kyoto Imperial University
Proc. Imp. Acad.	Proceedings of the Imperial Academy

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J. C **Young**: See Y. **Tanaka**

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Arb. Anat. Inst. Sendai	Arbeiten aus dem Anatomischen Institut zu Sendai
Bull. Hokkaido Agr. Exp. Sta.	Bullettin of the Hokkaido Agricultural Experimental Station
Chôsen Igk. Z.	Chôsen Igakkai Zassi
Fol. Anat. Jap.	Folia Anatomica Japonica
Hokuetsu Igk. Z.	Hokuetsu Igakkai Zassi
Ins. Mats.	Insecta Matsumurana
Jap. Jour. Genetics	Japanese Journal of Genetics
Jap. Jour. Limnol.	Japanese Journal of Limnology
Jour. Forest. Soc.	Journal of the Forestry Society
Kaibô Z.	Kaibô Zassi
Keijô Jour. Med.	Keijô Journal of Medicine
Manshû Igk. Z.	Manshû Igaku Zassi
Mem. Coll. Sci., Kyôto Imp. Univ.	Memoirs of the College of Science, Kyôto Imperial University
Mitt. Med. Akad. Kyôto	Mitteilungen aus der Medizinischen Akademie zu Kyôto

Nihon Byôri K.	Nihon Byôri Kai
Nagasaki Igk. Z.	Nagasaki Igakkai Zassi
Nihon Shika Igk. Z.	Nihon Shika Igakkai Zassi
Osaka Igk. Z.	Osaka Igakkai Zassi
Proc. Imp. Acad.	Proceedings of the Imperial Academy, Tôkyô
Rept. Saghalien Centr. Exp. Sta.	Report of the Saghalien Central Experimental Station
Saitô Hô-on Kai Mus. Res. Bull.	Saitô Hô-on Kai Museum Research Bullettin
Sci. Rept. Tôhoku Imp. Univ.	Science Reports of the Tôhoku Imperial University
Seiikai Z.	Seiikai Zassi
Trans. Sapporo Nat. Hist. Soc.	Transactions of the Sapporo Natural History Society

17. Thirteen new Polyclads from Misaki

By Kojiro KATO

Mitsui Institute of Marine Biology, Susaki near Simoda, Idu

(With 33 Text-figures and Plates XX–XXII)

This paper deals with thirteen new polyclads, listed below, which were found in the collection made in 1930–36 by Dr. M. Yeri in the vicinity of the Misaki Marine Biological Station. My hearty thanks are due to him for his kindness in having placed at my disposal the valuable material and life sketches of the worms.

ACOTYLEA

FAMILY STYLOCHIDAE

1. *Stylochus speciosus* sp. nov.
2. *Leptostylochus ovatus* sp. nov.
3. *Discostylochus yatsui* sp. nov.
4. *Cryptophallus eximius* sp. nov.

FAMILY CRYPTOCELIDAE

5. *Cryptocelis littoralis* sp. nov.

FAMILY LEPTOPLANIDAE

6. *Stylochoplana clara* sp. nov.

FAMILY PLANOCERIDAE

7. *Planocera profunda* sp. nov.
8. *Paraplanocera rubrifasciata* sp. nov.

COTYLEA

FAMILY PSEUDOCERIDAE

9. *Pseudoceros sagamianus* sp. nov.

FAMILY PROSTHIOSTOMIDAE

10. *Prosthiostomum auratum* sp. nov.
11. *Prosthiostomum ostreae* sp. nov.
12. *Prosthiostomum purum* sp. nov.
13. *Prosthiostomum yerii* sp. nov.

1. *Stylochus speciosus* sp. nov.

(Pl. XX, figs. 1, 2; Text-figs. 1–3)[1]

Five specimens of this species were found on oyster-shells cultivated in Moroiso Bay on Nov. 28, 1930.

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[1] Abbreviations in this and subsequent figures see p. 370.

In the living state the body is elongate oval in shape with somewhat frilled margin, measuring 32 mm long by 8 mm broad. The dorsal surface is of a greenish yellow color with a large number of dark spots. The ventral surface is paler and is devoid of spots.

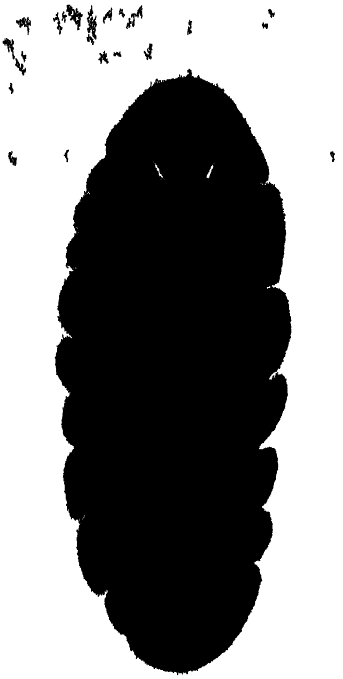

Fig 1 *Stylochus speciosus* ×2.5

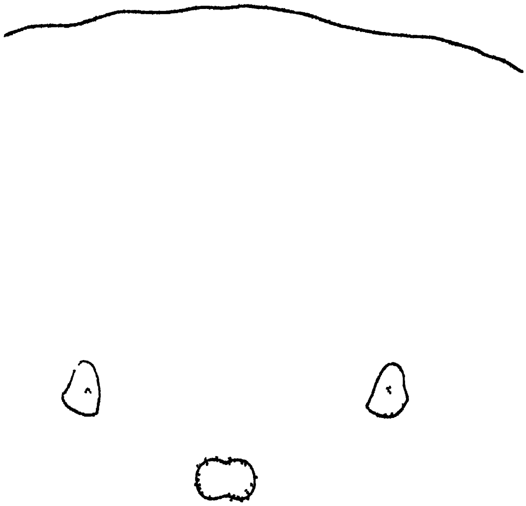

Fig 2 *Stylochus speciosus*, arrangement of eye spots ×17

The nuchal tentacles are slender and free from pigment, occurring near the hind end of the first sixth of the body. In the interior of the tentacles there are numerous eye-spots. The cerebral eyes are found on either side of the median line chiefly over the brain which lies a little behind the level of the tentacles. Along the margin of the anterior body-half there are densely arranged numerous eye-spots. The frontal eyes are few.

The general plan of the reproductive system is quite in accord with the type of the genus as shown in fig. 3. The seminal vesicle is a trilobed, anchor-shaped organ as in *Stylochus orientalis* (Bock, 1913), *ceylanicus* (Laidlaw, 1904), *ijimai* (Yeri and Kaburaki, 1918) and others. The prostate gland vesicle is of the *djiboutiensis*-type (Meixner, 1907) and almost as large as in *ijimai*, but much smaller than that of *aomori* (Kato, 1937 c). The extracapsular glands of the prostate are not only in the parenchyma around the vesicle but also in the ventral as well as dorsal parenchyma at a long distance from the vesicle and the secretion granules are carried by long efferent ducts to the prostate. Such an arrangement of the extracapsular gland is also noticed in both *ijimai* and *aomori*. The male and the female genital pore are closely applied, occurring in the middle between the last seventh and eighth of the body.

This species is distinguished from all other known ones of this genus, numbering about thirty, in the color-markings, the arrangement of eyes as well as in the larger size of the prostate vesicle in contrast to the thickness of the body.

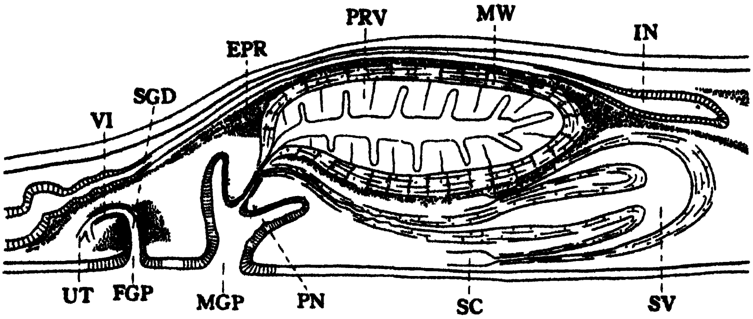

Fig. 3. *Stylochus speciosus;* longitudinal section through genital organs. ×70.

2. *Leptostylochus ovatus* sp. nov.

(Text-figs. 4, 5)

This new species is based on a single specimen obtained from the undersurface of stone between tidemarks at Araibama on Sept. 25, 1930.

In the preserved state the body is oval in shape, of a darkish brown color without any markings. It measures only 4.5 mm long by 3 mm broad at the widest part.

At the posterior limit of the second seventh of the body are found a pair of very small tentacles which are disposed about 0.3 mm apart. Only two tentacular eyespots are present. A large number of cerebral eye-spots are scattered over the brain region in front of the level of the tentacles and indistinctly divided into two groups by the median line. Along the margin of the anterior third of the body are a certain number of marginal eye-spots.

The epidermis is much thicker on the dorsal than on the ventral side and contains a great many minute rhabdites and basophilous

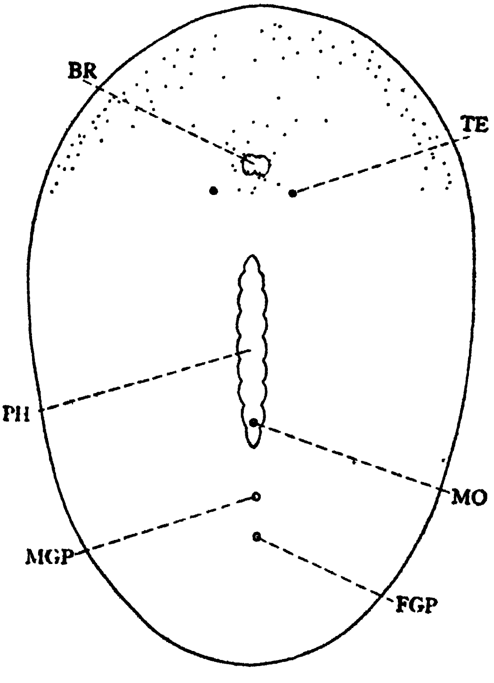

Fig. 4. *Leptostylochus ovatus.* ×18.

secretion. The dermal musculature is poorly developed. The mouth occurs near the posterior end of the plicated pharynx which occupies almost the middle third of the body. The main intestine gives off about 7 pairs of lateral branches which repeatedly ramify toward the margin of the body and form deep pouches on the ventral side. In the intestine are found a mass of monocystid gregarines.

The seminal canal enlarges into a false seminal vesicle immediately behind the posterior end of the pharyngeal pocket. The false seminal vesicle is an ovoid muscular organ and its efferent duct runs posteromediad for a short distance and unites with that from the other side to form a median ejaculatory duct. The ejaculatory duct is very short, opening into the prostate gland vesicle at its ventral side. The prostate vesicle is lined with a folded epithelium and coated with a thick musculature. The prostate makes posteroventrally its way at the tip of a small conical penis by the narrow duct which is surrounded by the inner parenchymatous tissue and the outer thick muscular envelope. The antrum masculinum is very large and lined with strongly ciliated cells. The testes and ovaries are not yet fully developed.

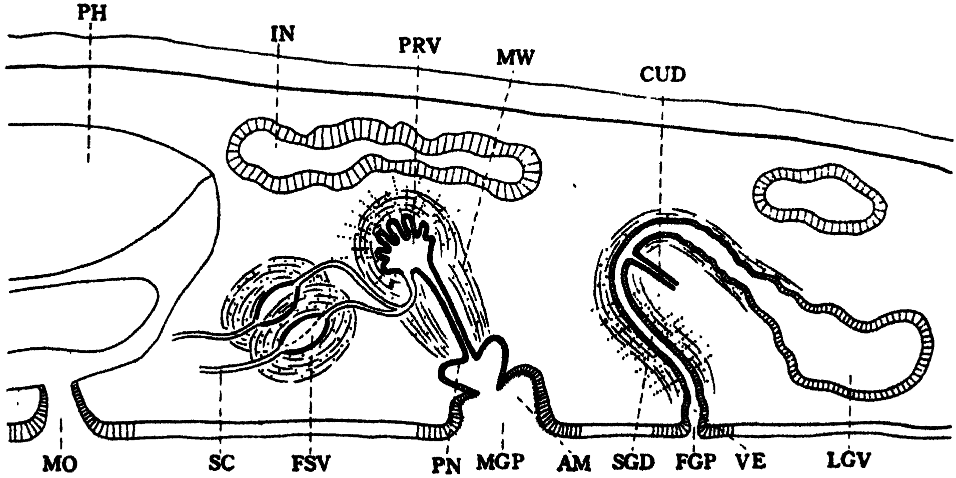

Fig. 5. *Leptostylochus ovatus*; longitudinal section through genital organs. ×150.

The narrow female genital pore lies immediately behind the male pore and lacks a sphincter around it. The vagina is provided with a thick muscular wall. The vagina externa is short and slightly enlarged, leading into the long shell gland duct. The vagina interna is also very short and after receiving from posteriad a common uterine duct continues to a moniliform duct of the Lang's glandular vesicle which is fairly large.

In the external appearance, this worm resembles well *Neostylochus fulvopunctatus* (Yeri and Kaburaki, 1920) but it belongs without doubt to *Leptostylochus* in the arrangement of eyes and the structure of genital organs. The shape of body is quite different from the slender form of *L. elongatus* (Bock, 1925 b) and *L. gracilis* (Kato, 1934 a). Moreover, the direct connection of the ejaculatory duct with the prostate vesicle is a most remarkable feature of this species. Besides the two species mentioned above, three other forms of *Leptostylochus* were recorded from Sydney (Bock, 1925 b), South Africa (Palombi, 1936) and Korea (Kato, 1937 b) respectively.

3. *Discostylochus yatsui* sp. nov.

(Pl. XX, figs. 6, 7; Text-figs. 6-8)

The collection contains a single specimen of Stylochid which has the genito-intestinal canal. Closer examination has revealed that this worm is referable to *Discostylochus* which is represented by a single species *parcus* (Bock, 1925 a) from Hawaii. The present specimen was collected on the underside of stone in the tidal zone at Araibama on May 15, 1933.

In the living state the body is elongate oval in shape with slightly pointed anterior and posterior extremities and of a firm consistency. It measures 40 mm in length and 15 mm in breadth.

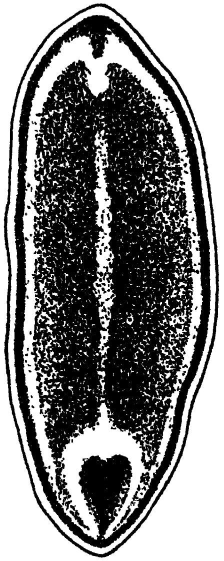

Fig. 6. *Discostylochus yatsui*. ×1.

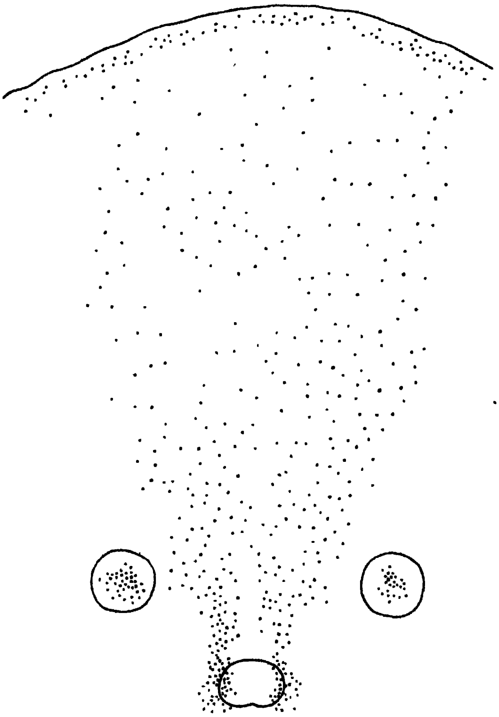

Fig. 7. *Discostylochus yatsui*; arrangement of eye-spots. ×17.

The central parts of the dorsal surface are of a dark yellowish brown color which fades away toward the margin and is fainter along the median line. The extreme margin is totally colorless and the submarginal zone is dark yellowish-brown. Cerebral region is colorless and a horse-shoe-shaped; colorless part occurs near the posterior end of the body. The ventral side is light brown.

A pair of small nuchal tentacles are situated at the hind limit of the first seventh of the body, at the base of each tentacle occur 30–40 eye-spots. The brain is situated slightly behind the level of the tentacles and on either side of it are scattered numerous cerebral eye-spots which are separated into two elongate clusters by the median line. A large number of eyes are disposed in the entire frontal part of the body and in addition numerous eyes are arranged along the margin in the anterior third of the body.

The epidermis is thicker on the dorsal side than on the ventral, composed of tall columnar cells and contains an abundance of minute eosinophilous secretion granules and a small number of rhabdites.

The musculature of the dorsal side consists of the outer longitudinal and the inner thick transverse layer. The ventral side is composed of the two longitudinal layers and the developed circular layer between them.

The mouth is situated at the posterior limit of the second third of the body close to the posterior end of the pharyngeal pocket. The pharynx is about two-thirds the body-length and moderately plicated with many deep side-chambers.

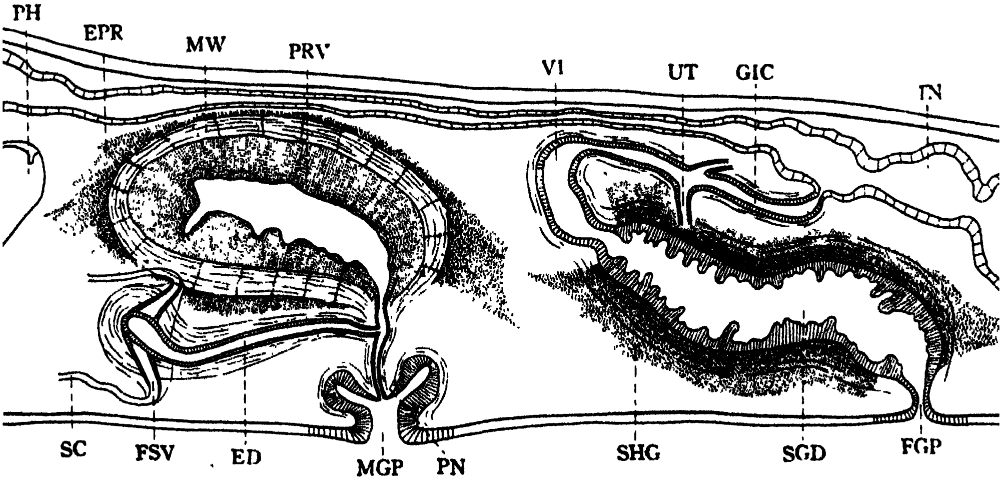

Fig. 8. *Discostylochus yatsui*; longitudinal section through genital organs. ×70.

Running on either side of the body the seminal canals, full of spermatozoa, turn mediad a little behind the posterior end of the pharyngeal pocket and gradually increase its diameter as well as the thickness of the muscular wall and finally unite to form an ejaculatory duct in the median line behind the posterior end of the prostate vesicle. In *parcus* the seminal canal enlarges into a distinct pear-shaped false seminal vesicle which sends out medially a short, muscular efferent duct which forms an ejaculatory duct with that from the other side. In the present species the false seminal vesicle is directly connected with the median ejaculatory duct and resembles the anchor-shaped seminal vesicle of *Stylochus*. The ejaculatory duct is very large with thick muscular walls and opens posteriorly into the duct from the prostate vesicle. The prostate vesicle is a large ovoid structure with thick muscular walls, through which open numerous efferent ducts of the extracapsular prostate glands. The extracapsular glands are embedded in the dorsal and the ventral parenchyma far from the vesicle as in *Stylochus speciosus*. The duct of the prostate runs down vertically and after receiving the ejaculatory duct makes its way at the tip of the bluntly conical penis.

Situated a little behind the male genital opening, the female gonopore passes anterodorsally into a long and wide shell gland duct through the short vagina externa. The shell gland duct is lined with much folded epithelium and on its entire course receives an abundance of shell secretion. Bending backward on the dorsal side the vagina interna receives a pair of uteri on either side and runs further posteriad to open as the genito-intestinal canal to the median intestinal branch. In *parcus* the common uterine duct is formed by the union of two uteri, but in this species it does not. Bock (1925 a, p. 41) states that "first of all, one would expect that, when Lang's glandular vesicle is present, the vagina would receive one unpaired median uterine duct instead of both uteri directly". But this does not hold in all polyclads, since *e. g. Paraplanocera* (Kato, 1936 b) has no common uterine duct.

I take pleasure in naming this species in honor of Professor N. Yatsu.

4. *Cryptophallus eximius* sp. nov.

(Pl. XX, figs. 3–5; Text-figs. 9–11)

A single specimen of this interesting polyclad provided with the genito-vaginal canal was collected under the stone near the low tidemark at Bentensita on July 26, 1930.

The body is elongate oval, very firm in consistency, 70 mm long by 30 mm broad in the expanded state. The dorsal surface is uniformly grayish brown and the ventral paler.

The measurements of the preserved specimen are as follows: The length of the body is 50 mm and the width 32 mm. The tentacular eyes from the anterior end are 9 mm and 1.8 mm apart. The mouth opening from the anterior end is 19 mm. The male genital pore from the posterior end is 10 mm and the female opening is 4 mm posterior to the male pore. The specimen was preserved in a nicely expanded condition (Pl. XX, fig. 3). The same condition was observed in the specimens of *Cryptophallus wahlbergi* (Bock, 1913) and *C. sondaicus* (Bock, 1925 b).

The tentacles are the slight elevations of epidermis. Each group of the tentacular eyes consists of about 13 ocelli. A large number of eyes are arranged in a single cluster as shown in fig. 9. Frontal eyes are not so many. Marginal eyes are found around the entire body, irregularly arranged in many rows. The ocelli are sparsely pigmented.

The epidermis is a little higher on the dorsal than on the ventral side.

It contains much eosinophilous secretion granules and a small quantity of shapeless cyanophilous secretion. The dermal musculature is powerful on the dorsal side than on the ventral and is composed of fairly complex circular and longitudinal muscle layers.

The mouth opening lies at the hind level of the second fifth of the body, and slightly behind the hind limit of the first fifth of the pharynx which is 28 mm long. The pharynx is plicated, provided with about 20 pairs of side-chambers.

The male genital pore lies directly beneath the posterior end of the pharynx, at about the anterior limit of the last fifth of the body. The seminal canals turn mediad at this level and enlarges into the elongate tubular false seminal vesicles as in *C. wahlbergi* and *sondaicus*. The seminal vesicles taper medio-dorsally and join into a single duct, the ejaculatory duct which proceeds ventrad to open at the tip of the penis. The penis is muscular, of a flat conical shape and is disposed vertically in the penis sheath. The prostate vesicle is very small and vertically placed over the penis opening near the apex of the penis together with the ejaculatory duct.

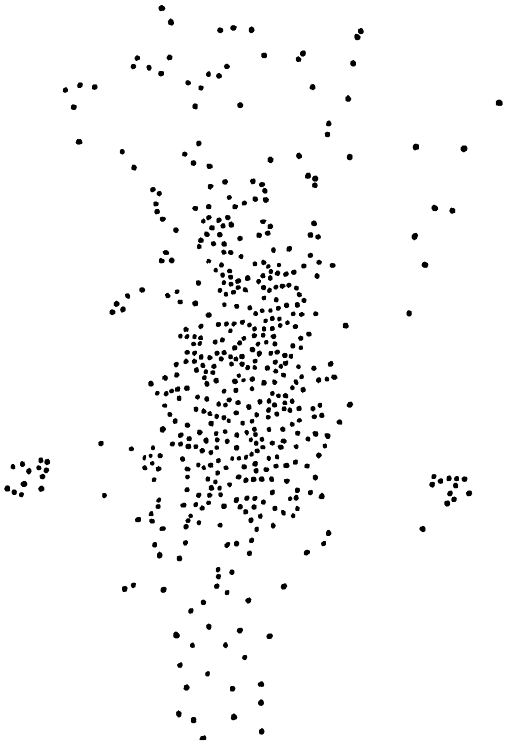

Fig. 9. *Cryptophallus eximius*; cerebral and tentacular eye-spots. ×28.

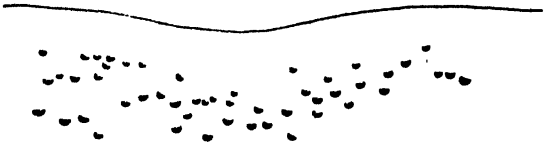

Fig. 10. *Cryptophallus eximius*; marginal eye-spots. ×70.

Occurring far posterior to the male gonopore, the female pore passes to the narrow vagina externa which continues anteriorly to the long shell gland duct. The short posterior part of the shell gland duct is extremely narrow and continues to the long broad middle portion which again tapers upwardly. This last portion of the duct is lined with much folded epithelium as in *sondaicus*. The shell glands open in *sondaicus* into this portion of the vagina, but in the present form they empty into the whole length of the shell gland duct as in *C. bartschi* (Kaburaki, 1923). On the dorsal side of the body the vagina interna receives ventrally two uteri, and takes a posteroventral course as the genito-vaginal canal to open into the vagina externa near the genital pore. The uteri are distended with a large quantity of ova.

Under the genus *Cryptophallus* have been recorded three species, *wahlbergi* from Port Natal, *sondaicus* from Amboina and *bartschi* from Tominado Island.

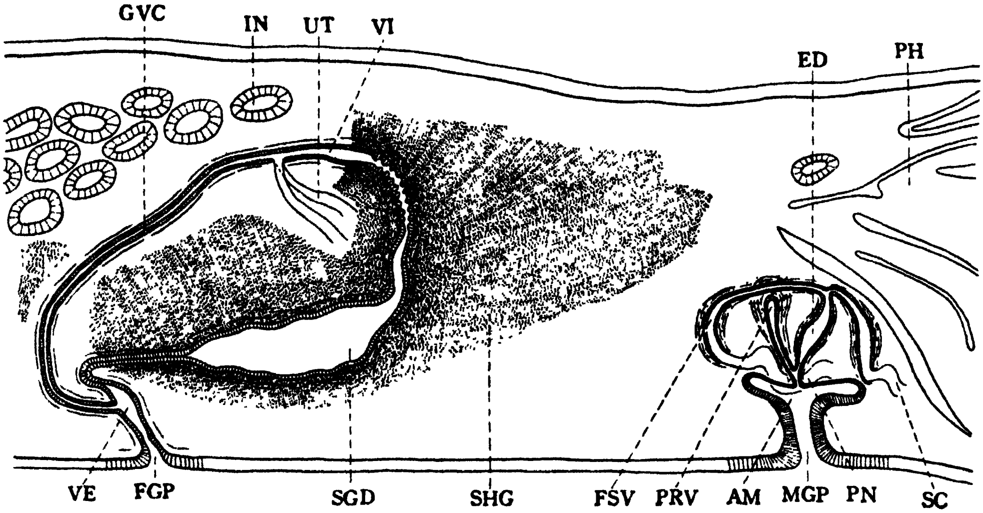

Fig. 11. *Cryptophallus eximius*; longitudinal section through genital organs. ×35.

The present species somewhat resembles *wahlbergi* but is distinguished from it in various minute points described above. Freeman (1933) described *Cryptophallus magnus* from the neighborhood of Puget Sound, North America. However, judging from the description and figures, this seems to be identical with Bock's *Kaburakia excelsa* from False Narrows, Nanaimo, Vancouver and Puget Sound (Bock, 1925 b, p. 142).

5. *Cryptocelis littoralis* sp. nov.

(Pl. XX, figs. 8, 9; Text-figs. 12 14)

This new species is based on two specimens collected under the stone at Aburatubo on May 28 and July 15, 1930.

The body in life is firm and thick, of an oval shape, slightly broader anteriorly. Both the anterior and posterior ends are terminated bluntly. It measures 50 mm in length and 35 mm across the broadest part of the body. The color of the body in alcohol is uniformly brown.

There is no tentacle. A couple of tentacular groups of eyes, 10–15 in number, are located at the hind end of the first ninth of the body, about 1.5 mm apart. Slightly in front of the level of the tentacular groups of eyes is situated the brain, over which are arranged two elongate clusters of numerous eye-spots. The cerebral eyes are deeply embedded in the parenchyma but the tentacular ones lie rather superficially. Marginal eye-spots are arranged in rows along the whole dorsal margin, being distributed more densely at the anterior end.

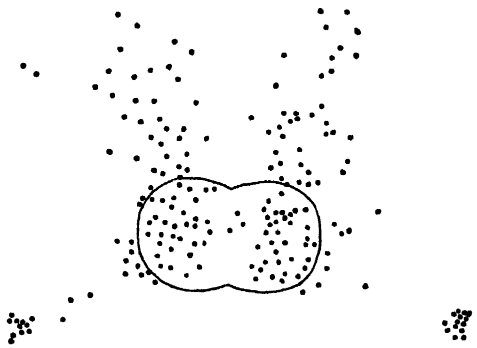

Fig. 12. *Cryptocelis littoralis*; cerebral and tentacular eye-spots. ×35.

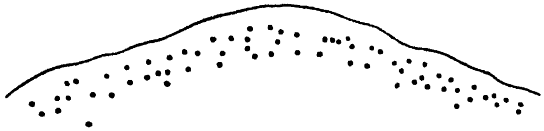

Fig. 13. *Cryptocelis littoralis*; marginal eye-spots. ×35.

The epidermis is rather thick, containing an abundance of eosinophilous secretion granules and spindle-shaped rhabdites. The musculature is well developed as in *Cryptocelis amakusaensis* (Kato, 1936 a).

The mouth lies near the center of the body and leads into the pharyngeal pocket containing the plicated pharynx of about one-third the length of the body.

Taking a tortuous course the seminal canal enormously enlarges near the posterior end of the pharyngeal pocket and abruptly tapers to run posteriad for a short distance. Here the canal pierces mediodorsally the thick muscular envelope of the prostate vesicle to open into it. The prostate vesicle is composed of two parts. The proximal part is a large slightly tortured ovoid body as in *ijimai* (Bock, 1923 a) and the distal part is a duct with numerous deep folds as in *alba* (Lang, 1884) and *amakusaensis*. In

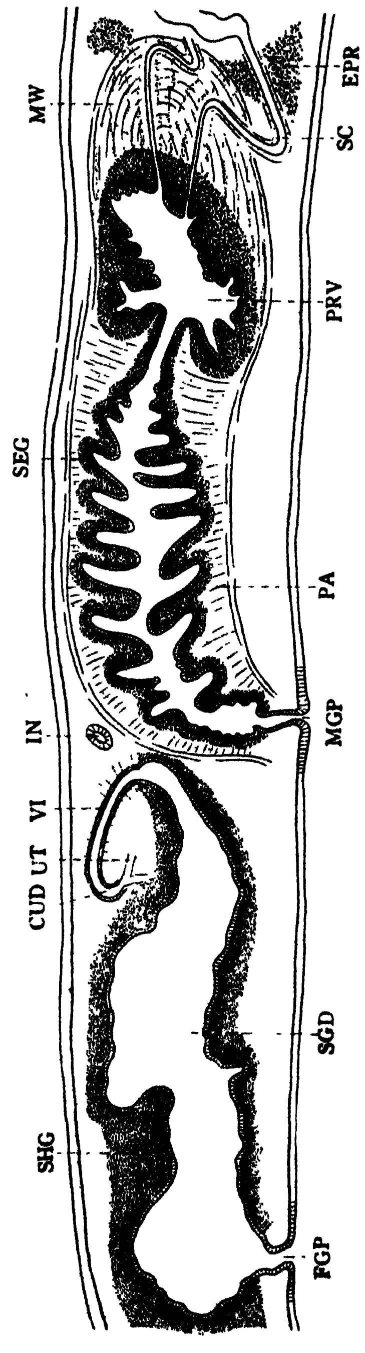

Fig. 14. *Cryptocelis littoralis*; longitudinal section through genital organs. ×22.

compacta (Lang, 1884) and *ijimai* this duct takes a spiral course and in *glandulata* (Jacubowa, 1909) it is provided with the special glandular vesicle.

The proximal part is lined with ciliated cuboidal epithelium and around it is an accumulation of eosinophilous secretion granules which are carried through the thick muscular wall by narrow ductules from the glands. They are densely grouped in the parenchyma directly behind the prostate. The distal part is lined with cuboidal cells and provided with an outer thick layer of the subepithelial gland cells. The prostate gradually tapers posteroventrally to open to the exterior by a narrow pore at about the level of the anterior margin of the last fourth of the body.

The female genital pore is widely separated from the male. The general plan of the female organs are quite in accord with those of other species of this genus. The shell gland duct extends as far as the wall of the prostate as in *amakusaensis* and passes dorsoposteriorly into the narrow vagina interna. Into the portion of the vagina are discharged fine secretion granules quite different from the shell gland secretion of a spindle shape. The vagina interna runs for a short distance and ventrally continues to the common uterine duct which eventually bifurcates into two uteri.

Under the genus *Cryptocelis* have been recorded three European and two Japanese species mentioned above. The planarian resembles *ijimai* obtained by Bock at Misaki from a depth of about 10 m, but is distinguished from it in the structure of the prostate vesicle and the total absence of the postgenital vesicle behind the female gonopore.

6. *Stylochoplana clara* sp. nov.

(Pl. XXI, fig. 5; Text-figs. 15, 16)

This species is commonly found living on *Zostera* and *Phyllospadix* all the year round.

In the living state the body is thin, flat, broad and rounded in front, tapering toward the posterior end which is slightly pointed. The large specimen is 5 mm long and 2 mm across the broadest anterior part of the body. The body is pellucid light green, slightly darker along the median line and the intestinal and the genital system are well discernible from outside.

At the hind margin of the second ninth of the body lie the brain and a pair of slender nuchal tentacles. At the base of the tentacles occur two or three eye-spots and on either side of the brain are found several cerebral eye-spots.

The mouth is located at the center of the body and at the hind end of the pharynx. The pharynx is poorly plicated, lacking distinct side-pockets and opens at its anterior end into the main intestine. Numerous cyanophilous glands open to the anterior wall of the mouth.

The epidermis consists of rather flat, cuboidal cells, containing a large nucleus and rod-shaped rhabdites. In spite of the thinness of the body the dermal musculature is well developed. The dorsal side is composed of the outer circular, the middle longitudinal and the inner circular layer; the ventral side of the outer longitudinal and the inner circular, and between them run two diagonal muscle layers whose fibers intersect at right angles. The dorsoventral muscle bundles are well developed.

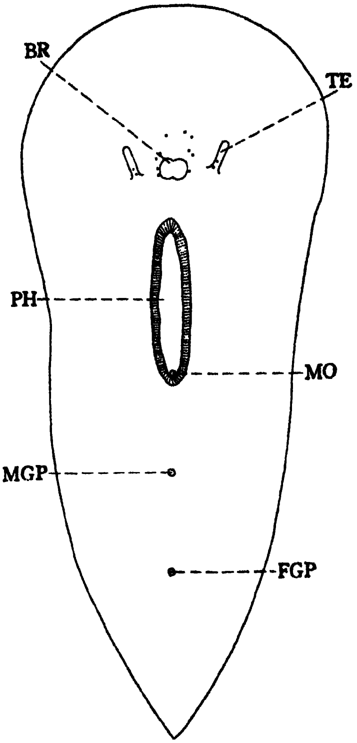

Fig. 15. *Stylochoplana clara.* ×24.

The seminal canals proceed backward along either side of the body and turn mediad slightly behind the end of the pharyngeal pocket to unite into a single duct which immediately passes into the seminal vesicle at its posteroventral aspect. The vesicle is tubular with a rather thick muscular wall. It curves upwardly to send off a narrow duct which piercing horizontally the strongly developed muscular envelope opens into the dorsal side of the prostate vesicle. This subcentral opening of the seminal vesicle to the prostate is an exceptional case in *Stylochoplana.* The prostate is a large elongate ovoid body lined with tall columnar cells and receives numerous efferent ducts of the extracapsular gland through its muscular wall. The vesicle tapers posteriorly to open at the apex of the penis. The penis is a large conical, muscular process with a slightly curved, pointed apex and is covered with a thick membrane similar to the basement membrane of the body wall. The penis is horizontally disposed in the specially differentiated penis sheath. The sheath is wide, provided at its hind end a deep glandular pouch lined with tall cells, into which is discharged the eosinophilous secretion carried from the glands scattered in the parenchyma around this pouch. Ventrally the penis sheath opens to the antrum masculinum with the muscular hemispherical process, the epithelium

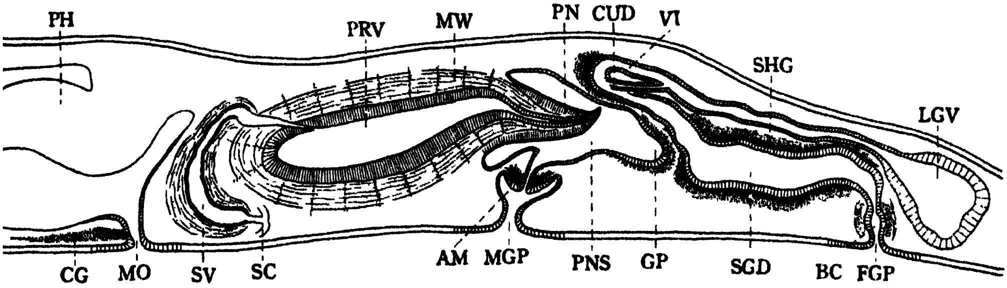

Fig. 16. *Stylochoplana clara;* longitudinal section through genital organs. ×95.

of which is glandular and taller than that of other parts. The male genital pore is situated at the hind margin of the second third of the body.

The female genital pore lies widely separated from the male, slightly in front of the middle between the male gonopore and the posterior end of the body. The vagina externa is surrounded with a strong muscular wall to form a bursa copulatrix. It passes into the wide shell gland duct which extends over the penis sheath and abruptly turns posteriad to lead to the vagina interna. The latter eventually receives a rather long common uterine duct and continues to the duct of the Lang's glandular vesicle. This vesicle is moderately large, located directly behind the female genital aperture. The shell gland secretion is of a spindle shape. The present planarian is entirely different from *Stylochoplana viridis* (Freeman, 1933) found on the eel grass near Puget Sound and all other species of this genus in the structure of the penis and its sheath and also in the possession of bursa copulatrix.

7. *Planocera profunda* sp. nov.

(Pl. XXI, figs. 6, 7; Text-figs. 17, 18)

Numerous specimens of this species were collected on Jan. 10, 1935 by the dredge from the depth of 18–20 fathoms off Moroiso.

The body in the preserved state is thin and oval, measuring 16 mm by 7 mm. The ground color of the body is light yellow and the dorsal surface is ornamented with dark spots and the reticulation of reddish brown minute pigment.

Slightly in front of the first third of the body lie a pair of long conical nuchal tentacles which are much pigmented. The arrangement of the eyes is similar to that of other *Planocera* as shown is fig. 17.

The mouth is near the center of the body and leads into the pharyngeal pocket containing the plicated pharynx. The main intestinal branches are in about 5 pairs.

The dorsal musculature consists of the outer thick longitudinal and the inner circular layer while on the ventral side are found the outer longitudinal, the middle diagonal and the inner longitudinal layer.

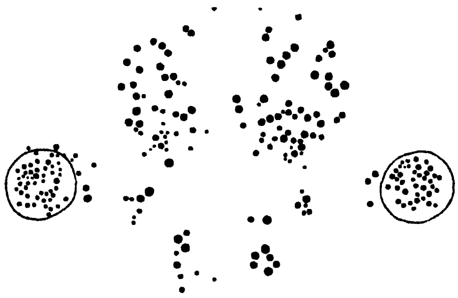

Fig. 17. *Planocera profunda*; eye-spots. ×22.

Numerous testes are in the ventral part. Situated slightly behind the posterior end of the second third of the body, the male genital pore continues anteriorly to the wide cirrus cavity lined with tall ciliated columnar cells, showing transitional stages to chitinous bristles commonly found on the lining of the cirrus in Planocerid-polyclads. The cirrus cavity continues anteriad to a wide duct from the prostate vesicle. Surrounding this duct is a mass of reticulated muscle fibers. The prostate vesicle is spherical, lined with much folded epithelium and coated with the muscular wall which are perforated by numerous efferent ducts of extracapsular gland. The tubular seminal vesicle receives from anteriad two seminal canals and posteriorly tapers into the ejaculatory duct which lies directly beneath the prostate, curving upward and opening into the duct from the prostate. The cirrus bulb together with the prostate vesicle are covered with a thick musculature.

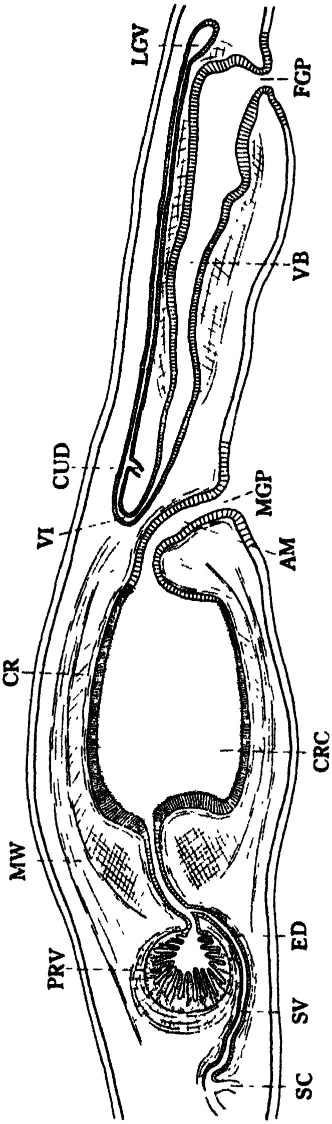

Fig. 18. *Planocera profunda*; longitudinal section through genital organs. ×35.

The female genital pore lies widely separated from the male. It directly leads into the wide elongate vagina bulbosa with a thick muscular wall. The vagina continues anteriorly to the shell gland duct which turns abruptly backward at the level of the male genital aperture to pass to the short vagina interna. The common uterine duct is very short, opening into the vagina near its turning point. The Lang's glandular vesicle is very small and ovoid lying immediately behind the level of the female genital pore. Shell gland secretion is not yet formed and the ovaries are not fully developed.

Under the genus *Planocera* have been recorded about fifteen species from various localities of the world. This species is distinguished from all the others heretofore described in the color-patterns of the dorsal surface and in the structure of the genital organs.

8. *Paraplanocera rubrifasciata* sp. nov.

(Pl. XXI, figs. 1–4; Text-figs. 19, 20)

This new species is based on a single specimen dredged on Sept. 9, 1932 from a depth of 15 fathoms off Hutamatiya.

In the preserved state the body is oval in shape with a slightly frilled margin and the anterior end a little broader than the posterior. It measures 15 mm long by 11 mm broad.

The ground color of the dorsal surface in alcohol is whitish yellow and spotted with brownish purple minute granules more densely distributed in the central part. Along the entire margin occurs a red band which is broken at many places. The red pigment is well preserved in the preparation, having withstood of various treatments received during the processes.

The nuchal tentacles are situated at the hind end of the first fourth of the body. The arrangement of eyes is shown in fig. 19.

The mouth lies near the center of the body. The genital apertures are closely disposed at about the anterior end of the last fourth of the body.

The internal organization of this species is almost in accord with that of *Paraplanocera misakiensis* (Kato, 1936 b). As to the coloration this species somewhat resembles *P. aurora*, but in the latter species the whole dorsal surface of the body is red as shown in the figure of Laidlaw (1903 c, Pl. 9, fig. 1). The paramarginal glands are also present as in *misakiensis*.

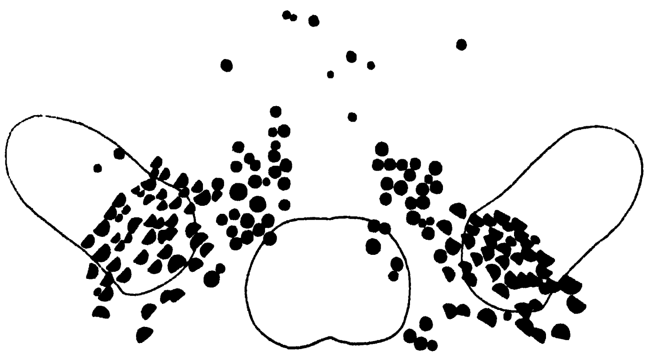

Fig. 19. *Paraplanocera rubrifasciata;* eye-spots. ×55.

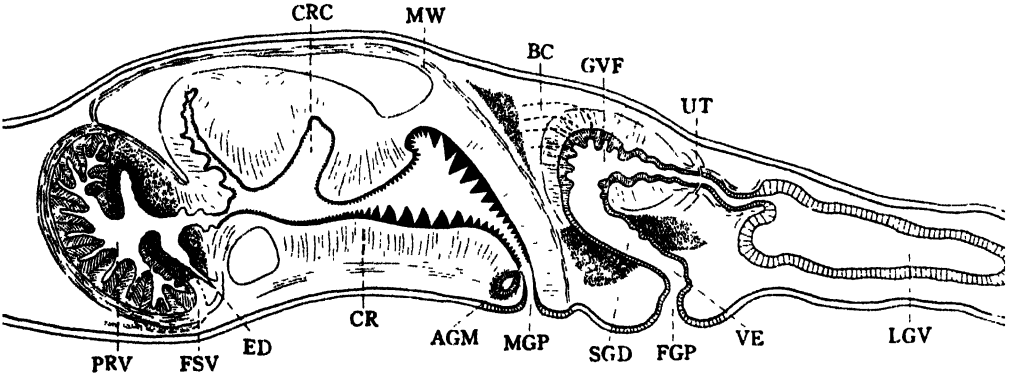

Fig. 20. *Paraplanocera rubrifasciata;* longitudinal section through genital organs. ×35.

A pair of glands accessory to the male antrum exist as in *discus* (Jacubowa, 1906), *marginata* (Meyer, 1922) and *misakiensis*. The ventral wall of the cirrus is rather smooth but its dorsal wall is irregularly folded to form a few large processes. The cirrus is devoid of chitinous folds and the inner surface of its cavity is beset with chitinous spines, those at the anterior part being very strong. The prostate vesicle is a large bun-shaped body with a rather thick muscular wall, consisting of two parts as in *misakiensis*. The anterior part is pileus shape, lined with a folded epithelium and contains a small quantity of eosinophilous secretion; the posterior part is rather small, containing much secretion. In the ventral part of the hind prostate opens the median ejaculatory duct which is formed by the union of two efferent ducts issuing from the false seminal vesicle on either side of the body. The structure of the bursa copulatrix and the seminal receptacle are very similar to those of *misakiensis*, but the glandular vesicle is much larger in this planarian. The uteri open separately into the vagina, abruptly tapering at the point of entrance.

9. *Pseudoceros sagamianus* sp. nov.

(Pl. XXII, figs. 9–11; Text-figs. 21, 22)

A single specimen of this *Pseudoceros* was collected on April 6, 1935 at Bentensita.

In the preserved state the body is elongate oval with somewhat frilled margin, 17 mm long by 12 mm broad. The color of the dorsal surface is brown, darker along the median line. Numerous white maculae of various sizes and shapes are found on the dorsal surface. The entire body margin is bordered with a narrow black band. The ventral surface is uniformly light brown.

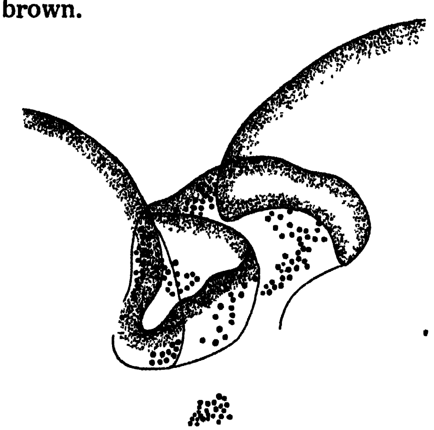

Fig. 21. *Pseudoceros sagamianus*; marginal tentacles and eye-spots. ×70.

The marginal tentacles appear as two short folds of the frontal margin of the body and are provided with a large number of eye-spots. The cerebral eye-spots, about 25 in number, form a single cluster near the base of the tentacular folds. The epidermis is thicker on the dorsal side than on the ventral and contains spindle-shaped rhabdites and fine secretion granules faintly stained with eosin. The dorsal epidermal cells contain a large amount of minute rod-shaped pigment granules in their proximal part.

A sucker lies at the center of the body. The mouth is situated closely behind the cluster of cerebral eye-spots. The pharynx is plicated and the intestinal branches form an anastomosing system.

The testes lie in the ventral half of the body. Proceeding forward the seminal canals turn medially near the level of the female genital pore and open separately into a large seminal vesicle of an ellipsoidal shape and with a moderately thick musculature. Issuing from the anteroventral part of the vesicle, the narrow ejaculatory duct takes a tortuous forward course to merge into the penis. Here it joins with the duct from the prostate vesicle. The prostate is rather small and lies horizontally over the base of the penis. It is of an elongate ovoid shape and is lined with strongly columnar cells and is provided with a muscular wall, through which pierce the ducts of the extracapsular gland. The elongate conical penis has a sharply pointed stylet and is disposed vertically in the penis sheath. The antrum masculinum is wide and deep, opening to the exterior by a narrow pore slightly in front of the middle between the anterior end of the body and the sucker.

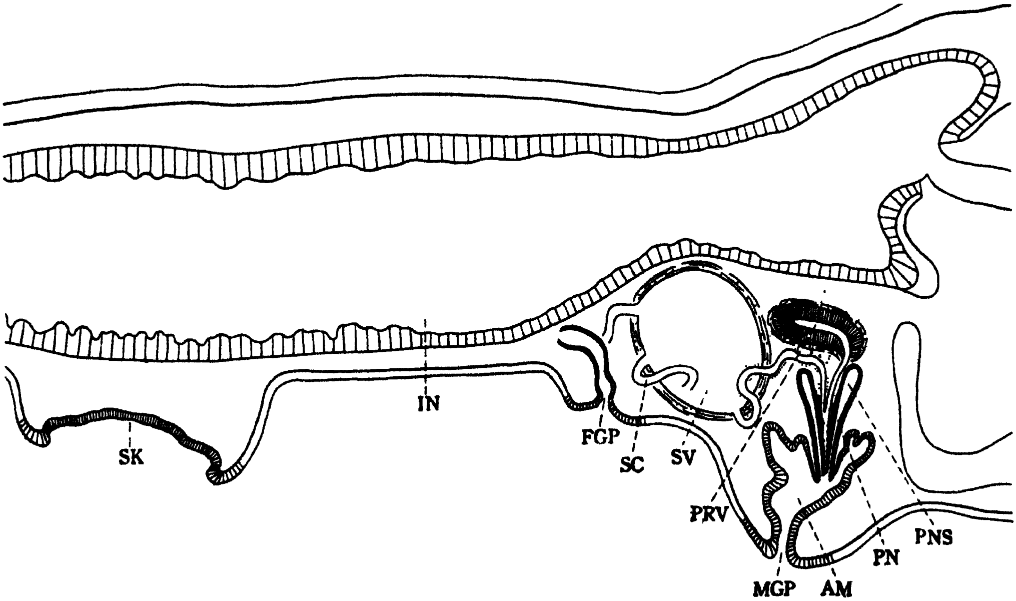

Fig. 22. *Pseudoceros sagamianus;* longitudinal section through genital organs. ×35.

The female genital aperture is a little behind the male pore. The female genital organs are in the same plan as in other species of this genus. The testes are in a fully developed state and the seminal canals and vesicle are full of sperm. The ovaries, however, are not yet developed and the shell gland secretion are not found.

Of about twenty species of *Pseudoceros* this worm resembles *P. nigromarginatus* (Yeri and Kaburaki, 1918) in the possession of the black margin, but is distinguished from it in the maculated dorsal color-markings.

10. *Prosthiostomum auratum* sp. nov.

(Pl. XXII, fig. 8; Text-figs. 23, 24)

This is one of the four new species of *Prosthiostomum.* This worm was found on Aug. 28, 1936 creeping on *Phyllospadix.*

The body in life is slender, anteriorly rounded and posteriorly tapering to a point and of a firm consistency, measuring 8 mm long by 1 mm broad. The color of the body is uniformly golden yellow without any markings whatever and is a little fainter along the median line. The ovaries appear as whitish spots.

At the distance of 0.5 mm from the anterior extremity lies the brain, on either side of which are cerebral eyes in two linear groups of 7 ocelli each. The marginal eyes about 12 in number are arranged in a single row along the frontal margin. The mouth is located immediately behind the brain. The pharynx is long cylindrical. The anterior median branch of the intestine runs for a short distance to end blindly. The ventral musculature is strongly developed compared with that of the dorsal and owing to this structure the animal is considerably warped at the time of fixation. A large sucker is situated slightly behind the middle of the body.

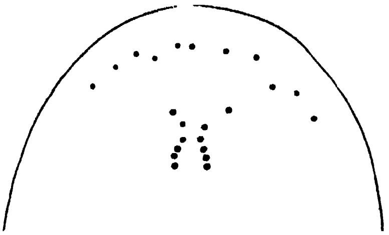

Fig. 23. *Prosthiostomum auratum*, eye-spots. × 35.

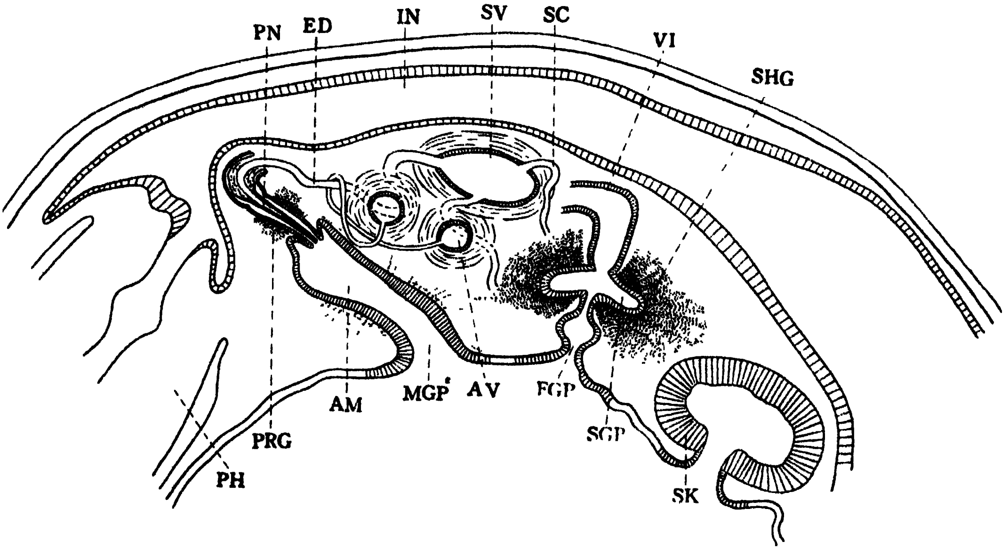

Fig. 24. *Prosthiostomum auratum*; longitudinal section through genital organs. × 120.

The arrangement of the genital organs is closely similar to that found in other species of this genus as shown in fig. 24. The seminal canals open into the large seminal vesicle at the posterolateral respects. The ejaculatory duct is very long, receiving in the midway a pair of ducts from the accessory vesicles which are moderately large. The penis is provided with a sharply pointed slender stylet at its apex. Surrounding the antrum masculinum are scattered numerous unicellular glands which discharge the secretion into the antrum.

11. *Prosthiostomum ostreae* sp. nov.

(Pl. XXII, figs. 4, 5: Text-figs. 25–27)

This new species is based on three specimens found on Nov. 29, 1932 on cultivated oyster-shells at Moroiso.

The body is very elongate with a broadly rounded anterior end and a pointed posterior extremity. The large specimen measures 26 mm by 2 mm. The dorsal surface is light brown with a median brown band and maculated evenly with reddish brown. Some white specks occur in the brown band. The margin is partly of a lemon yellow color. The cerebral region is colorless.

The cerebral eyes are divided into two groups by the median line and each consists of 20–25 ocelli. Marginal eyes numbering 80–90 are irregularly scattered along the anterior margin. The mouth lies immediately behind the brain and leads into a cylindrical pharynx. A large sucker occurs at about the middle of the body. The median anterior branch of the intestine is short.

The genital apertures lie closely behind the pharyngeal sheath. The seminal canals, proceeding from behind, abruptly turn mediad immediatly behind the penis to enter the anteroventral end of the large ovoid seminal vesicle, which is provided with a thick muscular wall, and gives rise anteriorly to the ejaculatory duct. After receiving the ducts from two small spherical accessory vesicles, the ejaculatory duct merges into the base of the penis and opens to the exterior at the tip of the pointed stylet. The stylet is rather thick and abruptly tapers from the middle of its length. The penis sheath is a little constricted at the middle and in its lower half open the prostate glands. Into the antrum are discharged much secretion from the glands scattered in the surrounding parenchyma.

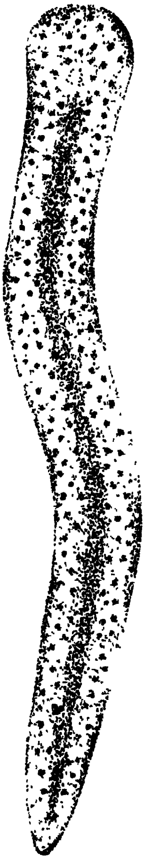

Fig. 25. *Prosthiostomum ostreae.* ×4.

Half way between the male genital pore and the sucker occurs the female aperture which upwardly passes into an expanded shell gland pouch. The vagina interna turns anteriad to receive the uteri. While the seminal canals and vesicle are full of sperm, the female reproductive organs are still in a rudimental condition.

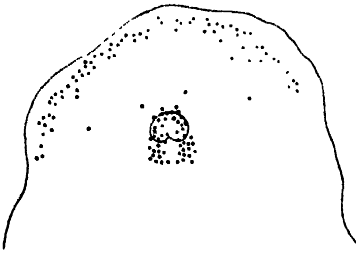

Fig. 26. *Prosthiostomum ostreae*; arrangement of eye-spots. ×18.

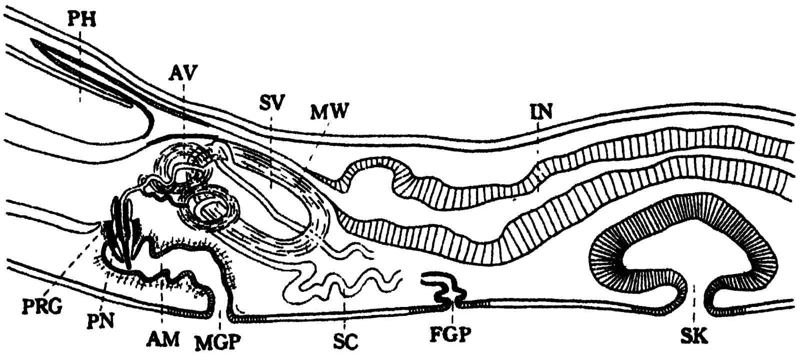

Fig. 27. *Prosthiostomum ostreae;* Longitudinal section through genital organs. ×55.

12. *Prosthiostomum purum* sp. nov.

(Pl. XXII, figs. 6, 7; Text-figs. 28–30)

Six specimens of this species were collected in the autumn of 1932 from a depth of 15 fathoms off Hutamatiya. Another specimen was obtained on Sept. 16, 1936 at Susaki, Idu.

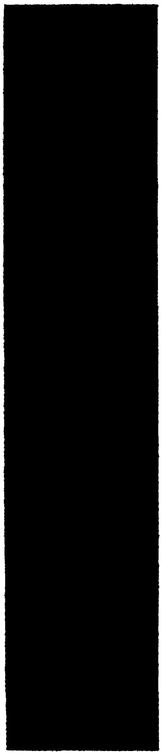

Fig. 28. *Prosthiostomum purum.* ×5.

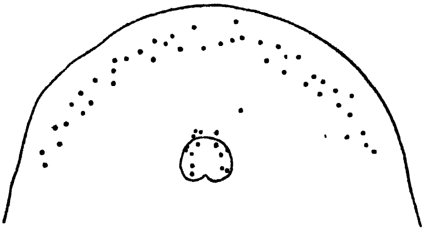

Fig. 29. *Prosthiostomum purum;* arrangement of eye-spots. ×35.

The body in life is very elongate and of a delicate consistency, measuring 15–20 mm long by about 1 mm broad. The anterior end is rounded and the posterior tapers to a point. The body is translucent milky white without any color-patterns. The arrangement of eyes is shown in fig. 29, the cerebral eyes are few and the marginal fairly numerous.

The mouth lies immediately behind the brain and leads into the pharyngeal chamber which contains a cylindrical pharynx. The pharynx is very short in contrast to the body-length, occupying one-fifth or one-sixth the body-length. The anterior median branch of the intestine is short. A small sucker is located at about the center of the body.

In other species of *Prosthiostomum* the copulatory organs occur usually immediately behind the posterior end of pharynx. In the present species they are widely separated from it owing to the shortness of the pharynx. The general plan of the genital system is in accord with the type of the genus. In the immature specimens the accessory vesicles are distinctly separated from each other, but in a mature one collected at Susaki they are found to be so closely approximated that a part of muscle fibers of each vesicle wall overlap. Such a feature reminds us of the same structure of *Enchiridium periommatum* (Bock, 1913).

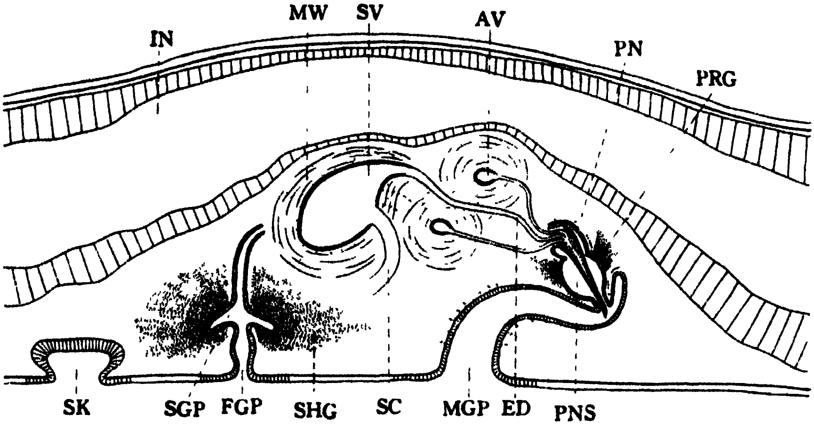

Fig. 30. *Prosthiostomum purum*; longitudinal section through genital organs. ×85.

13. *Prosthiostomum yerii* sp. nov.

(Pl. XXII, figs. 1-3; Text-figs. 31-33)

One specimen of this species was obtained on Sept. 7, 1932 from a depth of 15 fathoms off Hutamatiya. Four specimens were collected in the autumn of 1936 at Susaki.

The body is broad with the rounded anterior and pointed posterior ends. It is of firm consistency. The large specimen measures 25 mm long by 4 mm broad.

The dorsal surface is generally of a milky white with a faint touch of brown, having a longitudinal reddish brown band running from behind the cerebral eyes to the posterior end of the body. In one specimen this band is bordered with a dark stripe. Over the cerebral region is a patch of the reddish brown color, which gives off a median and two anterolateral processes. The region over the cerebral eyes is colorless. The cerebral eyes are fairly abundant and indistinctly divided into two lateral clusters which converge anteriorly. The marginal eyes are also numerous, distributed along the anterior end of the body as is shown in fig. 32.

The epidermis is higher dorsally than ventrally, containing an abundance of slender rhabdites. The mouth lies immediately behind the brain and leads into the cylindrical pharynx. The pharynx is rather thin, inasmuch as the anterior median branch of the intestine runs over the pharynx to the cerebral region. A large sucker is situated slightly behind the center of the body.

The male genital pore lies immediately behind the end of the pharyngeal pocket and leads upwardly into a wide antrum which passes into the penis sheath. Into the constricted ventral half of the sheath are discharged prostatic secretion granules. The penis is a cylindrical muscular structure provided with a stylet at the tip. At the base of the penis the ejaculatory duct receives two short ducts of the accessory vesicles. The accessory vesicle is moderately large, of a pyriform shape and its efferent duct is coated with the musculature derived from the surrounding musculature of the vesicle itself. Situated behind the accessory vesicles, the seminal vesicle is rather small, ovoidal, provided with a thin muscular walls and receives at the posterolateral respects a pair of the seminal canals.

The female genital aperture lies a little anterior to

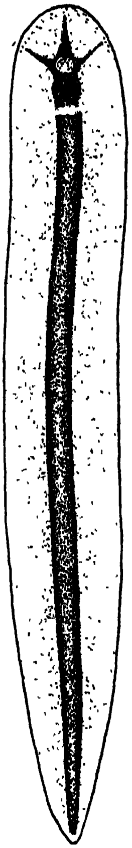

Fig. 31. ***Prosthiostomum yerii.*** ×4.

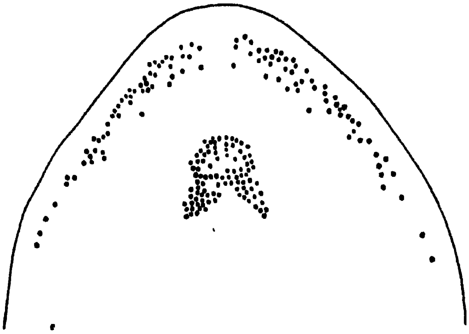

Fig. 32. ***Prosthiostomum yerii;*** arrangement of eye-spots. ×17.

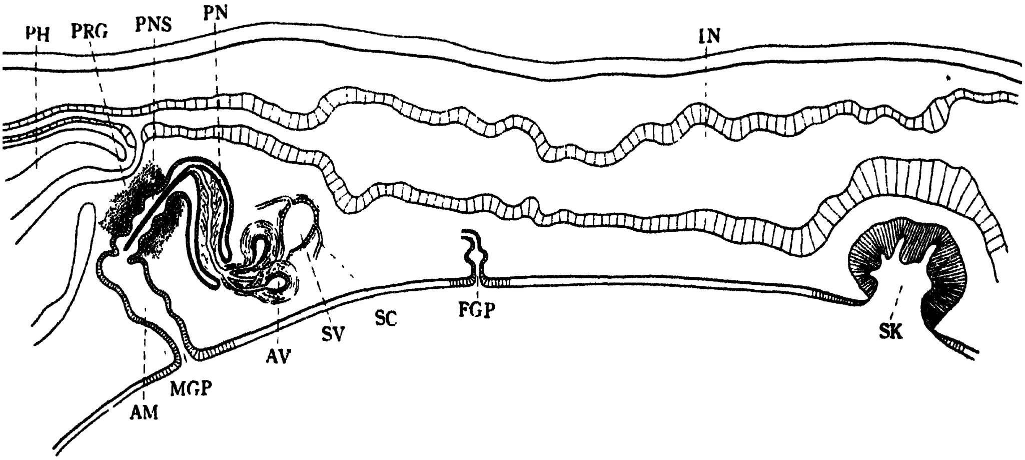

Fig. 33. ***Prosthiostomum yerii;*** longitudinal section through genital organs. ×70.

the half way between the male pore and the sucker. The female genital organs are not fully developed but the shell gland pouch and the anteriorly directed vagina interna are observed.

In 1925 Bock erected the genus *Euprosthiostomum* for *E. adhaerens* living associated with hermit crabs in Panama and the following diagnosis was given: "1) Prosthistomids with marginal eyes only in the anterior region of the body and frontal eyes. 2) No gut branch above the pharyngeal pocket; 3) The two separate accessory vesicles of the male apparatus small, club-shaped, with short efferent ducts forming the direct continuation of the vesicle; 4) The proximal part of the vagina directed forwards; 5) Sucker at a decided distance from the female gonopore and situated near the posterior margin of the body."

Of the above five points 2) and 4) can be seen in *Prosthiostomum* as especially pointed out in the preceeding species in this paper. In studying *Euprosthiostomum viscosum* from Napoli Palombi (1936) emended 4) as follows: "The proximal part of the vagina directed forwards or backwards". The present species agrees well *Euprosthiostomum* in this feature, but differs from it in 1) and 5). At any rate this worm seems to be an intermediate form between *Prosthiostomum* and *Euprosthiostomum* and I would rather put it in the former genus than in the latter.

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ABBREVIATIONS

AGM accessory gland of male genital organs; AM antrum masculinum; AV accessory vesicle; BC bursa copulatrix; BR brain; CG cyanophilous gland; CR cirrus; CRC cirrus cavity; CUD common uterine duct; ED ejaculatory duct; EPR extracapsular prostate gland; FGP female genital pore; FSV false seminal vesicle; GIC genito-intestinal canal; GP glandular pouch; GVC genito-vaginal canal; GVF glandular vesicle of female genital organs; IN intestine; LGV Lang's glandular vesicle; MGP male genital pore; MO mouth; MW muscular wall; PA parenchyma; PH pharynx; PN penis; PNS penis sheath; PRG prostate gland; PRV prostate gland vesicle; SC seminal canal; SEG subepithelial gland; SGD shell gland duct; SGP shell gland pouch; SHG shell gland; SK sucker; SR seminal receptacle; SV seminal vesicle; TE tentacle; UT uterus; VB vagina bulbosa; VE vagina externa; VI vagina interna; ♂ male genital pore; ♀ female genital pore.

EXPLANATION OF PLATES

PLATE XX

1 *Stylochus speciosus* sp. nov. ×1
2 Ditto, longitudinal section through genital organs. ×40
3 *Cryptophallus eximius* sp. nov. ×1
4 Ditto, a part of longitudinal section of body showing penis. ×26
5 Ditto, longitudinal section through genital organs showing folded epithelium of vagina and opening of common uterine duct. ×26
6 *Discostylochus yatsui* sp. nov. ×1
7 Ditto, longitudinal section through genital organs. ×40
8 *Cryptocelis littoralis* sp. nov. ×1
9 Ditto, longitudinal section through genital organs. ×15

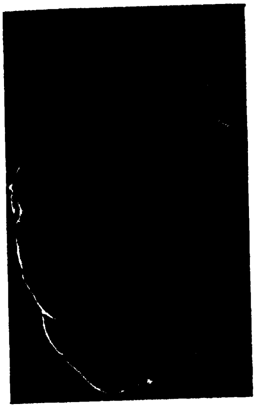
PLATE XXI

1 *Paraplanocera rubrifasciata* sp. nov. ×1
2 Ditto, longitudinal section through genital organs. ×26
3 Ditto, longitudinal section through genital organs showing glandular vesicle. ×40

4 Ditto, a portion of longitudinal section of body showing bursa copulatrix and seminal receptacle. ×26
5 *Stylochoplana clara* sp. nov., longitudinal section through genital organs. ×60
6 *Planocera profunda* sp. nov. ×1
7 Ditto, longitudinal section through genital organs. ×40

PLATE XXII

1 *Prosthiostomum yerii* sp. nov., anterior end of body. ×15
2, 3 Ditto, longitudinal section through genital organs. ×40
4 *Prosthiostomum ostreae* sp. nov., anterior end of body. ×15
5 Ditto, longitudinal section through genital organs. ×40
6 *Prosthiostomum purum* sp. nov., anterior end of body. ×26
7 Ditto, longitudinal section through genital organs. ×40
8 *Prosthiostomum auratum* sp. nov., median sagittal section of body. ×40
9 *Pseudoceros sagamianus* sp. nov. ×1
10, 11 Ditto, longitudinal section through genital organs. ×26



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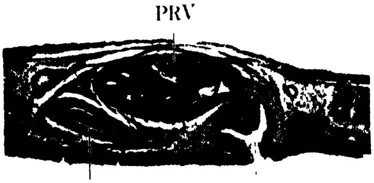

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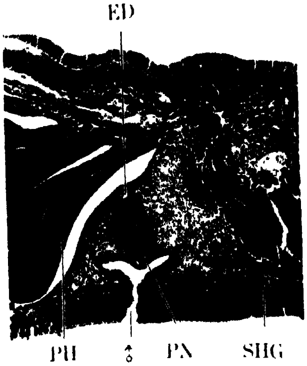

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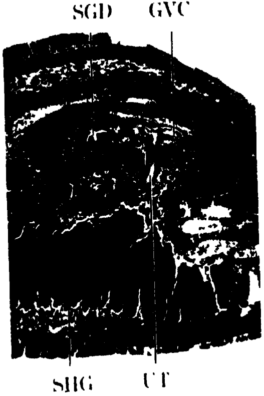

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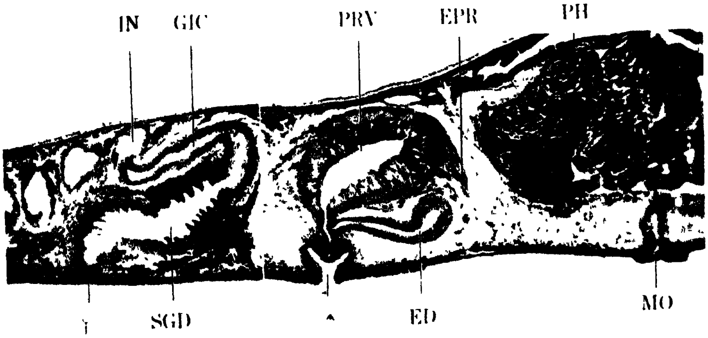

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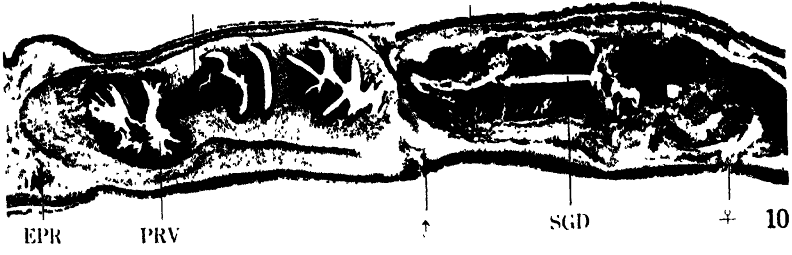

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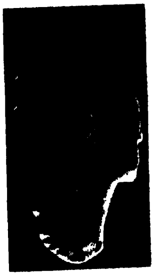

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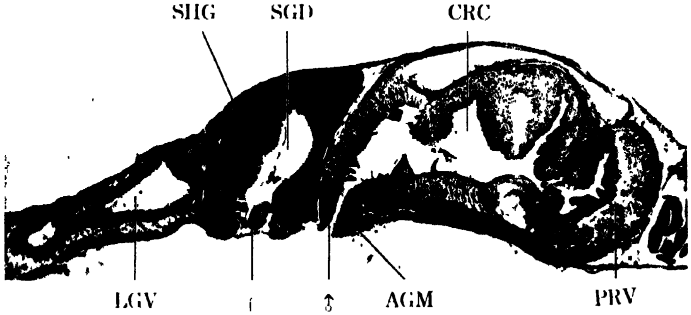
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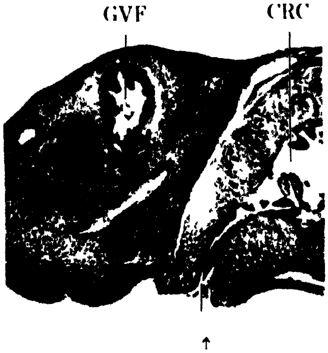
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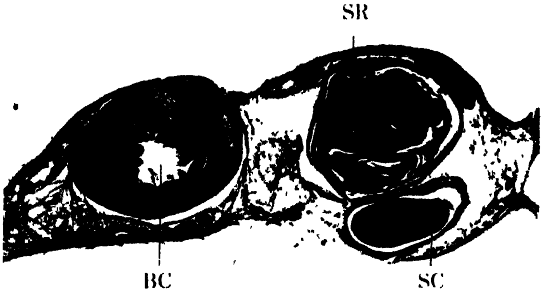
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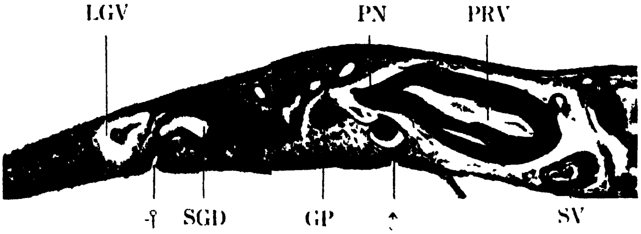
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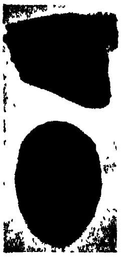

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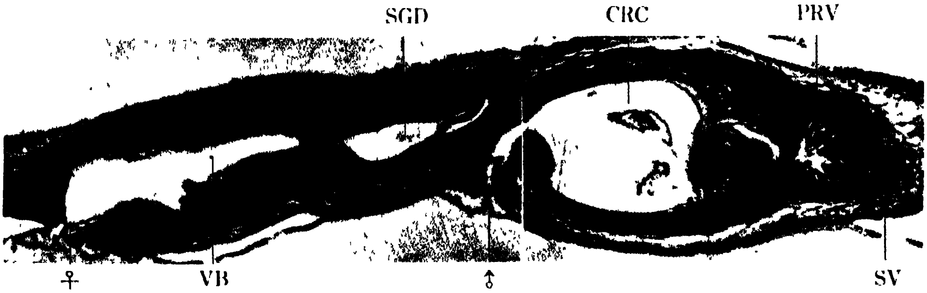
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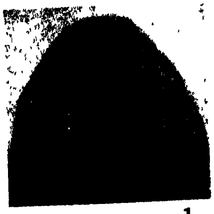

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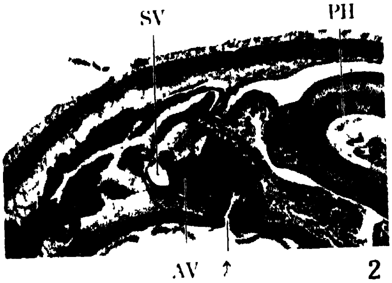

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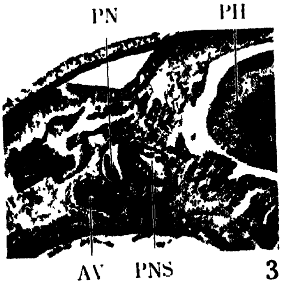

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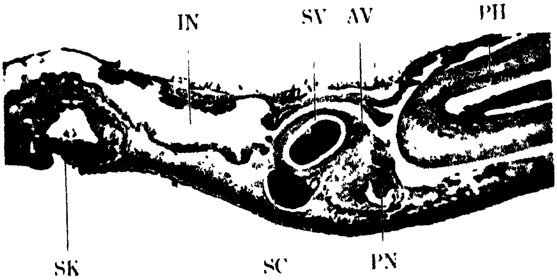

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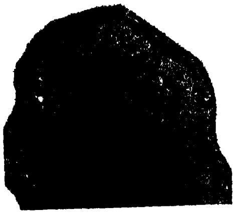

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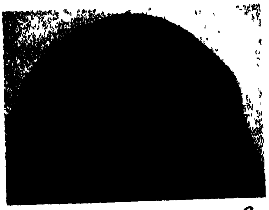

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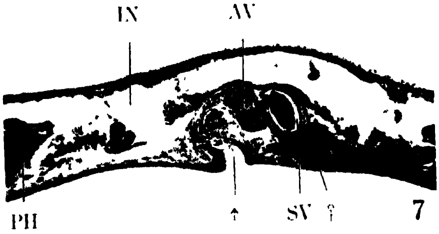

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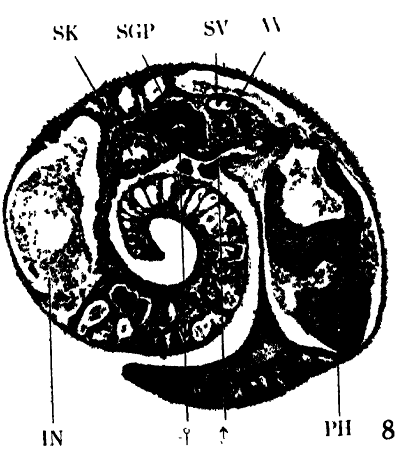

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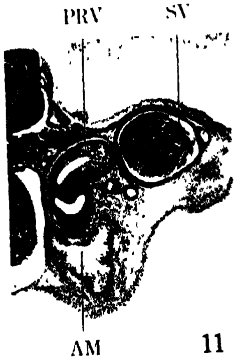

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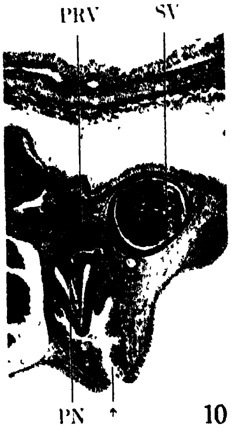

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18. Transplantation Experiments in *Planaria gonocephala* Dugès

By Yô K. OKADA and Hisao SUGINO
(Zoological Institute, Kyoto Imperial University)

(With 118 Figures in the Text)

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INTRODUCTION

I. Grafting experiments in planarians have been carried out since T. H. MORGAN began them in 1900. In one of his experiments two beheaded individuals of *Bipalium kewense* were united by their anterior cut surfaces, but in another the posterior ends of two short pieces were united. In either case no regeneration occurred at the junction. Later the composite animal was cut apart by an oblique section that passed across the line of union, so that each piece retained at its most distal point (at one side) a piece of the other individual in a reversed position. As a result a head in the former and a tail in the latter were produced. Regeneration in either case was obviously heteropolar to the small portion that was retained. But in these methods of experimentation it remains in doubt, whether the regeneration occurred in reality only from the small piece of tissue of another individual which was situated at the end, and whether the larger piece of tissue which was exposed on the cut surface did not participate in the process. Hence L. V. MORGAN (1906) cut *Phagocata gracilis* and *Planaria maculata* at different levels, i. e. just behind the eye (anterior level), in the middle of the pharyngeal sheath (middle level) or behind the pharynx (posterior level), and used any two of these as components. After heteropolar union by their anterior ends, one of the components was cut off near the line of union. It was observed here that the regeneration at the posterior end of the small piece was often reversed by the influence of the larger constituent. LUS (1924) cut a tail bipolar individual, which was derived from an experimentally produced two-tailed specimen of *Bdellocephala punctata* (autocomplantation or idioplastic reindividualization), near the line of union, and obtained in one case a head on the posterior cut surface of the shorter constituent. But LI (1928), who carried out these experiments on *Planaria lugubris*, never obtained any case in which the reversal of polarity in one component is caused by the influence of the other.

Reversal of polarity in a graft is explained by SANTOS (1931) as follows: That regeneration is reversed as regards the polarity of the shorter component is not by itself a proof of an induction by the larger component. For even very short pieces of a planarian are by themselves capable of giving rise to bipolar forms. Thus the reversal of polarity in the shorter component united in opposite direction represents no more, at the time of the determination of polarity in the newly formed tissue, than the influence on the posterior (or anterior) cut surface of the anterior (or posterior), where regeneration is inhibited by the presence of the larger component. But whether the reversal of polarity above observed in the graft piece is brought about, as SANTOS states, by the same set of conditions as a heteromorphic regeneration in short isolated pieces, is a problem which requires further consideration.

II. As SANTOS himself acknowledges, there are other cases of polarity reversal which are caused by transplantation. That in the experiments of L. V. MORGAN above described, besides the mere fact that of a pair of components united one is larger than the other, difference of the levels to which these components belong plays an important rôle, can easily be seen from her results. Also as indicated in the experiments of transplantation of small pieces by MORETTI (1912, in *Planaria torva*, *Pl. alpina*, *Polycelis nigra*) and SANTOS (1931, in *Planaria dorotocephala*, *Pl. maculata*) as well as in the results of GEBHARDT's experiments with regeneration buds (1926, in *Planaria lugubris*) different regions of a planarian show by no means uniform differentiation. The potency of head formation decreases from the anterior towards the posterior end of the body, while that of tail formation, on the contrary, being strongest at the posterior end, decreases towards the head. For the explanation of these regional differences we are not forced to assume settled differentiation at different levels of the body. The fact may easily be understood as manifestation of gradients, as CHILD and his adherents claim, a physiological dominance being represented at one end of the body. But it is also known that either on isolation or on heterotopic transplantation the head or the tail can form nothing more than its own, i. e. regeneration is unipotential. Though the morphogenetic potency of the newly formed tissue in the regeneration of these regions may at first be indifferent, its determination implies no more the dominance of the organism as a whole, but lies evidently in the graft itself. Moreover, if a head piece be taken as the graft, it demonstrates the capacity to establish a new polarity in reorganizing the host tissue behind it. According to GOETSCH (1929) the reorganization does not involve the host entirely, but is restricted to those portions which are drawn out of the host as the graft develops. SANTOS (1929, 1931), however, drew attention to the fact that the ganglionic region, if transplanted, not only induces an outgrowth from the host tissue, but also causes the tissue organization of the host itself to alter with the resulting reversal of the polarity. As was already shown by CHILD, the formation of a head represents, even in the ordinary regeneration process of an isolated piece, a motive force for the morphogenesis of the posterior regions. Thus the head of a planarian resembles the upper lip of the blastopore in the early development of amphibians and other vertebrates (SPEMANN 1916; in bird WADDINGTON 1933; in fish LUTHER 1935) in having a sufficient effect as an organizer upon undifferentiated tissues. But this phenomenon can not be attributed to a special function of the ganglionic region, for it was shown by OKADA and SUGINO (1934) in *Planaria gonocephala* that the prepharyngeal tissue, if transplanted into the postpharyngeal region, derives the appearance of a new pharynx as well as the ganglionic graft does. We are led by this fact to a belief that the reorganization of tissue and the induction of pharyngeal development are aroused, at least in planarians, by some change in the physiological gradients that are continuous from one end to the other.

III. GOETSCH (1921, 1922) regards the formation of new tissue ("Regeneration" in his own words) and the union ("Verwachsung") to be antagonistic to each other, for if two postpharyngeal pieces of *Planaria lugubris* are brought into heteropolar union by their anterior ends no "Regeneration" occurs between them. But LI (1928), who has repeated the same experiment, comes to the conclusion that such a relation can hold only when there exists both structurally and materially no defect between two components. Thus, if a piece from the middle region of a planarian is removed and the remaining anterior and posterior parts are united, even in those cases where the latter are completely healed with no perceptible wound, the middle portion that is lacking comes to be repaird by the formation of new tissue, i. e. through regeneration as it is called by the author. As regards the case of GOETSCH above mentioned of the heteropolar union of tail pieces, he further contends that inhibition of regeneration is not here due to the union itself, but to the condition that the polarity of each component is opposed to that of the other, i. e. to the heteropolarity. SANTOS (1931) also observed that, if a piece other than the head is transplanted into another region of the body and the union is complete, new tissue is always formed between it and the host. But he calls attention to the fact that, if instead, a head piece is used as the graft, it directly reorganizes the host tissue, and such formation of new tissue as above does not follow.

IV. Now, the methods and aims of our experiments which were carried out during the five years from 1930 to 1935 were as follows: 1) Small square or rectangular pieces were cut from different levels of a planarian and transplanted into the same (autoplastic transplantation) or another individual (homoplastic t.) at different levels either in normal or reversed orientation. The object of this series of experiments was to determine the degrees of specialization from the head to the tail end of the animal. On the other hand, parts were united, which were thus known to be provided with different specialization, in the hope that some new light might be thrown on the problem above discussed as to the various influences on the host. In such cases it is evident that the graft itself will be influenced by the host according to the level of transplantation. It is also necessary in these experiments to take into consideration the effect of quantitative difference between the sizes of the graft and the host. 2) Hence, two pieces of comparatively large size cut out at the same or at different levels of the body were united in normal or reversed orientation, and in the light of these experiments the results of the preceding experiments of transplantation of small pieces were criticized. Again, subsequent cuts were performed in these experiments for the purpose of investigating that in what manner the difference in size and degree of specialization between the components of the compound body determine in particular the polarity of the regenerated part on the operated surface. 3) Homopleural or heteropleural reindividualization was made with lateral halves of two worms which were longitudinally split. This implies combination of the results of the first series of experiments with those of the second, representing the union of two halves with equal or unequal differentiation along a wide range from one end to the other of the worms, with the aim of elucidating the mechanism of subsequent reorganization of tissue and the formation of new organs.

The results of these experiments were already briefly reported in Proc. Imp. Acad. Tokyo, X (1934) pp. 37–40, 107–110. In the following pages the whole aspect of our study will be published, since some deficiencies in the preceding paper could be filled up through the experiments continued during the course of the following year.

MATERIAL AND METHODS OF EXPERIMENTS

As the material was used *Planaria gonocephala* which is the most common in this locality and can easily be collected and cultured. The experimental animals were preserved in glass vessels, 20 cm. in diameter and 10 cm. high, each containing about 100 individuals. Water was changed during summer once a day and during winter once every third or fourth day. The untouched animals as well as those operated were fed with hen's liver once a week.

Planaria gonocephala in the vicinity of Kyoto being seldom provided with sexual organs, asexual worms only were employed in the experiments. Preserved specimens of the planarians multiplied vigorously even in the laboratory, fission taking place usually immediately or a little behind, rarely before, the pharynx.

Worms 10–18 mm. in length were chosen for operation, but those under 5 mm. were also occasionally employed. Those which were used as hosts were anaesthetized in an aqueous solution of chloretone (0,2–0,4%) and put on a glass plate which had been immersed in melted paraffin and thereafter covered with a thin layer of gelatine. With a sharp scalpel for ophthalmic use under the binocular microscope, a hole was cut at a certain level of the host body in the shape of a square (one side about 1 mm. in length), into which a piece from the same or another individual (auto- or homoplastic graft) was inserted with a certain orientation. In homoplastic transplantation, it is to be mentioned, the graft was taken from a worm not anaesthetized. Operation being ended, the worm was put on a watch glass with a little moisture, and was kept in the dark for over 24 hours in a small moist chamber. Sometimes the watch glass was lined with wet filter paper and the operated specimen was put on it. But even when the paper was not in use, the worm was kept wet enough because of water drops condensed upon the watch glass by lower nocturnal temperature, never coming to be dried up so as to cause death. Operated animals were sometimes covered also with tissue paper. In summer months they were put into a refrigerator in order that maceration of the cut surface might be prevented. In most cases, it is to be added, the host was beheaded to be kept quiet.

Although not necessary in the case of small pieces, when two large pieces were to be united measures must be taken for preventing the gliding apart of the surfaces of contact. For this purpose one cut surface was previously made convex and the other concave. When two halves from worms which were longitudinally split through the median plane were united parallel with each other in normal or reversed orientation, the compound formed by their union was always covered with tissue paper, the outer portions of which, moreover, were weighted with fragments of glass.

Each worm on which transplantation had proved successful was put in a Petri dish, observed every day under the binocular microscope, recorded and, if necessary, sketched.

A glass plate covered with a thin layer of paraffin on which a gelatine solution (2 g. of gelatine in 100 cc. of tap water) is poured and dried up into a thin layer makes operation which is performed upon it very easy. The worm adheres, as if pasted, to the plate, as the moisture on the ventral surface of the body is absorbed through the latter. This makes it very easy to operate upon a worm at any level and in any direction with a scalpel. Though the mucus secreted all the time from the surface of the worm offers an obstacle to the union of the graft and the host, it is nevertheless beneficial for preventing the worm which is exposed to the air from desiccation.

TERMINOLOGY IN EXPERIMENTS

The pharynx serving as a landmark, those parts of the body lying anterior and posterior to it are called respectively the prepharyngeal and the postpharyngeal regions, while the middle part including the pharynx the pharyngeal region. If necessary, each of these regions is distinguished into subdivisions, i. e. anterior, middle and posterior, with the exception of two extremities which are the head and the tail.

By transplants or grafts are meant, of course, small pieces used for transplantation, and by recipients or hosts worms that receive them. So far as the prepharyngeal (*AP*) or the postpharyngeal region (*PP*) is concerned, the point at about the centre in each region is chosen in our experiments as the level of transplantation (fig. 1 b). Pieces which are used as grafts in our experiments are the following. From the head region: piece in front of the eyes (preocular graft, fig. 1 a, *a*), ganglionic portion including the eyes (ocular or ganglionic graft, *g*) and auricular portion on either side (auricular graft, *l*). From the prepharyngeal region: its middle portion (prepharyngeal graft, *ap*) and piece just before the pharynx (*ph. a*). From the pharyngeal region (*PH*): basal portion of the pharynx (pharyngeal basis, *ph. b*) and portion in the middle of the region (midpharyngeal graft, *ph. m*). From the postpharyngeal region: its middle portion (postpharyngeal graft, *pp*) and piece near the tail end (tail graft, *t*).

As regards the manner of union, those cases in which the polarity of the graft is identical with that of the host, i. e. both are in the same direction, are spoken of as in normal orientation, while those cases in which the polarity is opposite to each other as in reversed orientation. Sometimes, terms isopolar and heteropolar directions are used in their places. In the cases where large pieces are united, it is needed to designate not only the direction but also the original position of each. A piece is said to be in normal anteroposterior (*a-p*) orientation, when it is set with normal orientation into the level corresponding to its original position, or in normal posteroanterior (*p-a*) orientation, when it is united according to its original polarity, but the position is changed anteroposteriorly. When large pieces are united in reversed orientation, there are distinguished anteroanterior (*a-a*) union, where two pieces unite on their anterior cut surfaces, and posteroposterior (*p-p*) union, where they unite on their posterior cut surfaces.

Finally, dorsoventral differentiation is so significant in planarians that, if a graft is transplanted in reversed vertical orientation, no reversal in property can occur either in the host epithelium or in the graft epithelium to that of the other side (cf. the results of experiments by L. V. MORGAN, 1906 and also by SANTOS, 1931). Hence, these points must be brought out more clearly before we proceed to give accounts of our operations. Those cases in which such a vertical reversal does not exist are called dorsodorsal (*d-d*) or vertically normal transplantations, distinguished from the opposite cases which are called dorsoventral (*d-v*) or vertically reversed transplantations. Besides, explanations on different modes of "takes" will be given occasionally.

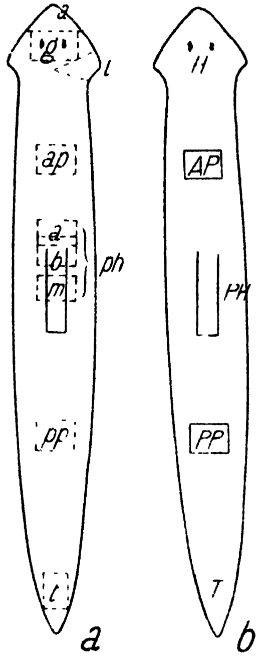


Fig. 1. *Planaria gonocephala* Dugès, showing a) pieces of transplantation and b) levels to be transplanted. Abbreviations: *a* preocular graft. *AP* prepharyngeal region, *ap* prepharyngeal graft, *g* ganglionic graft, *H* head region, *l* auricular graft, *PH* pharyngeal region, *ph* pharyngeal graft (*a* immediate anterior, *b* basal, *m* middle), *PP* postpharyngeal region, *pp* postpharyngeal graft, *T* tail region, *t* tail graft.

EXPERIMENTS

I. TRANSPLANTATION OF SMALL PIECES

Generally speaking, there are two different modes of union which occur between the transplanted piece and the host: first, the dorsal and the ventral epithelia of a graft unite in the normal way with the dorsal and the ventral epithelia respectively of the host (dorsodorsal ventroventral (*dd-vv*) union), and vice versa (dorsoventral ventrodorsal (*dv-vd*) union); second, both the dorsal and the ventral epithelia of a graft unite merely with either the dorsal or the ventral epithelium of the host (dorsal-ventral dorsal (*dv-d*) or dorsal-ventral ventral (*dv-v*) union). These different modes of union result in profound differences in further development of the graft. When a graft perfectly unites with the host, i. e. the cut surface of the former perfectly unites with the host tissue on all sides, the graft piece will cause an elevation on either the dorsal or the ventral surface, a corresponding invagination of various degrees taking place on the ventral or the dorsal surface. At the time when the elevation or the invagination is not yet formed, if we cut the host animal anteriorly or posteriorly to that level so that an original cut surface of the graft may be exposed, regeneration takes place at this end either independently or in cooperation with the host tissue.

Between the graft and the host can occur, of course, incomplete union of every sort, accompanied according to its degree with various morphogenetic effects.

A. Head Grafts

In most cases a rectangular piece including the eyes and the brain was used as the graft (fig. 1 a, *g*). Such a head piece cut apart just behind the eyes is by itself no more able to regenerate tail. But if possessed backwards of a short postcephalic part, it regenerates tail as well as pharynx. We have not yet experienced any production of a heteromorphic head by an isolated head piece of *Planaria gonocephala.*

1. Transplantation of the ganglionic piece into the prepharyngeal region

Out of 28 cases in all of successful transplantation, resorption of the graft by the host occurred in one case only. Here also, the graft which was transplanted into the subocular position of the host developed once into a perfect head. But as another head regenerated from the anterior end of the host grew, the graft head gradually decreased in size and was ultimately resorbed. In the remaining cases a head, perfect or imperfect in different degrees, developed from the graft. The experiments and their results are summarized in table I.

Table I

Transplantation of Ganglionic Piece into Prepharyngeal Region.

Experiments			Results						
			Normal Head			Heteromorphic Head			
Mode of Union	Secondary Operation	Number	Plane	Dorsal Out-growth	Ventral Out-growth	Plane	Dorsal Out-growth	Ventral Out-growth	Resorption
Union complete	Not performed	1						1*	
	Cut anteriorly	4	3			1			
	Cut posteriorly	1	1						
Union incomplete	Not performed	9		3			5	1	
	Cut anteriorly	5		2			2		1
Reversed dorso-ventrally		3		1			2		
Part of Graft not united		5				4		1	

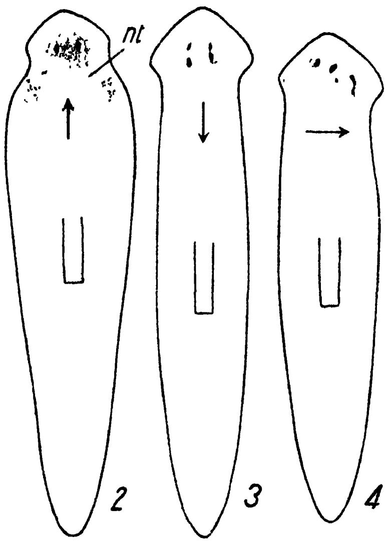
* Ventral elevation

Cases in which union is complete: Union after operation between graft and host being complete, as we have already stated, a dorsal (or ventral) elevation accompanied with a corresponding ventral (or dorsal) invagination occurs at the level of transplantation.

If the host is cut just before the graft which is transplanted in normal orientation, a head regenerates from the latter and replaces the host head. Fig. 2 represents such a case in which new tissue (*nt*), though in a small quantity, is formed along the line of union between the graft and the host.

In case, too, a graft is transplanted in reversed orientation into the host, if after union the latter is cut anteriorly, a head is regenerated from the original posterior end of the graft and dominates over the regions that follow. In fig. 3 is illustrated a case in which a head is regenerated from the common cut surface consisting of the posterior end of the graft and the anterior one of the host, and, moreover, new eyes are formed in front of the old ones so that two eyes are now situated antero-posteriorly on each side. The eyes on the right side are, however, found in a common white area.

In fig. 4 is shown the result of transplantation of a head piece into the host nearly at right angles to the long axis of the latter, of which after union the anterior portion was cut off. In this case, on the cut surface the left side of the graft was exposed, from the anterior angle of which the graft gradually turned forwards. Although the eye spots, accordingly, drew nearer to the normal situation, they could not reach it even in 42 days after transplantation. A supernumerary pair of small eyes then developed besides the original ones as illustrated in the figure.

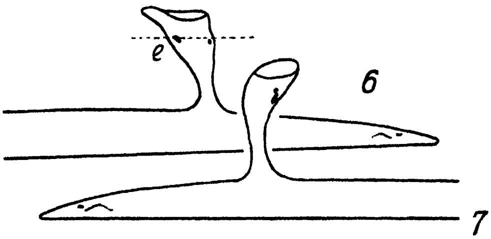


Figs. 2-4. Results of transplantation of a head piece into the prepharyngeal region in normal (fig. 2), reversed (fig. 3) and rectangular direction (fig. 4), and subsequent removal of the host part anterior to the graft, original polarity of the latter being indicated by an arrow; fig. 2, 11 days; fig. 3, 31 days; fig. 4, 42 days after the first operation. *nt* new tissue appeared between host and graft.

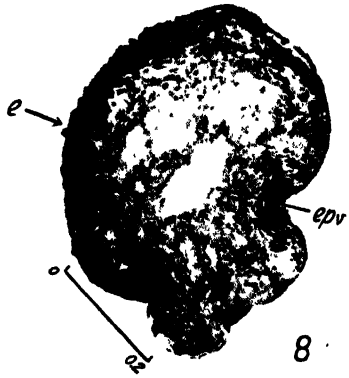
In the foregoing two kinds of transplantation, i. e. in normal and reversed unions, if the portion lying behind the graft is cut off, the latter develops into a head turned backwards (Okada and Sugino 1934, I, fig. 1). In fig. 5 is shown such an example where, though regeneration occurred to a slight extent from the host tissue on both sides of the cut surface, the new product could develop into neither a tail nor a head. In this experiment also, there could be recognized no reorganization of the anterior branch of the intestine lying between the host head and the head grown from the graft in the reversed direction. Hence in these worms, provided with neither pharynx nor mouth, waste products of the body wholly accumulate in the old intestine as is shown black in the photograph of the figure.

Cases in which union is incomplete: In case both the dorsal and the ventral epithelia of a graft are united merely with either the dorsal or the ventral epithelium of the host, the graft develops, regardless of its orientation, always at right angles or nearly so to the dorsal or the ventral surface of the host. Here also, differences in the mode of development of the graft depend, needless to say, upon the mode of union between the graft and the host.

Fig. 5. In the same transplantation as before posterior part of the host was removed, with resulting production of a head at the posterior end.



Figs. 6-7. Dorsal outgrowthes as a result of union of both dorsal and ventral epithelia of the graft with the host dorsal epithelium; fig. 6, 26 days; fig. 7, 28 days.



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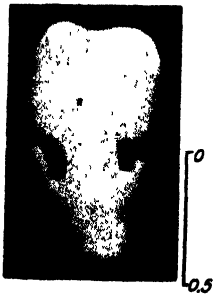

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Fig. 8. Transverse section through the ocular level of the head in fig. 6; *e* eye, *epv* graft ventral epithelium. Fig. 9. Head cast off from the specimen in fig. 7.

In those cases where most of the dorsal epithelium of a graft is united with the dorsal epithelium of the host and most of the ventral epithelium of the former is buried in the parenchyma of the latter, the graft develops into a tubular form. If the ventral epithelium of a graft is buried to a lesser extent, the greater part being exposed to the exterior, the graft develops into a funnel or cup-form, the inner surface of which is lined with the ventral epithelium of the graft origin. Figs. 6 and 7 represent such examples. In fig. 8 is given a cross section of the graft of fig. 6 at the ocular level. Fig. 9 shows the graft head detached from the worm of fig. 7.

In a specimen in which union of the graft dorsal epithelium with that of the host was complete and the graft ventral epithelium was entirely buried in the host body, an opening abruptly broke out the line of union during the development of the dorsal elevation, resulting in the exposure of the graft ventral epithelium to the exterior (see fig. 10).

The stalk or peduncle of the graft head which has grown into a funnel- or a cup-form is covered with the host dorsal epithelium. It becomes thinner as time passes, and finally breaks off at the place where it is thinnest. Detached heads are not provided with the power of regeneration and are dead in a few days. In figs. 11, 12 and 13 are shown specimens in which the graft had developed to a certain extent, and yet in these cases the graft was finally detached through the dwindling of the stalk. Here, during the development, besides the original ones, one or two new eyes were formed in the old tissue of the graft (figs. 11, 12) or in the outgrowth from the host (fig. 13). A graft head thus provided with excess eyes, if detached from the host, often develops into a biaxial head. In the specimens represented in figs. 11 and 12, some changes in relation to the original longer axis are observed in the graft head. Generally speaking, no matter in what orientation a graft head may be united with the host, the end which has remained free always develops into the anterior end of the head developed therefrom. That is to say, a head piece is endowed with the potency to differentiate in any direction into a head. To such polygonal heads developed from the head grafts SANTOS (1931) applied the term "multipolar".

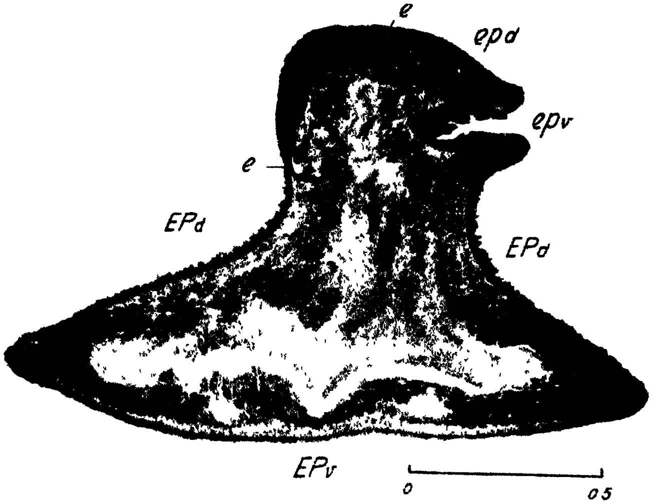
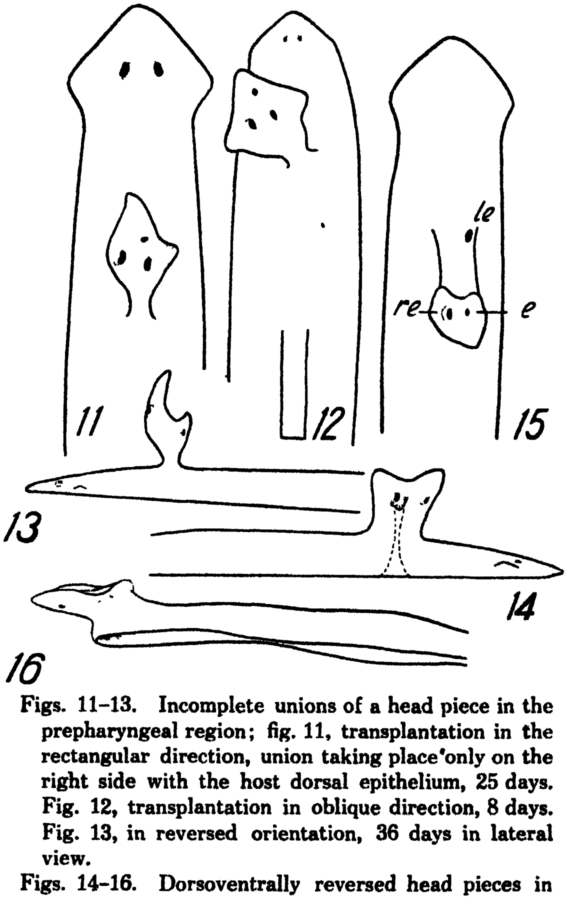


Fig. 10. Transverse section of a specimen in which union of the graft dorsal epithelium (*epd*) with that of the host (*EPd*) is more complete, and the enclosed ventral epithelium of the graft (*epv*) breaks through to open to the exterior: *e* eye, *EP* host epithelium, *ep* graft epithelium, *d* dorsal, *v* ventral.

Dorsoventral reversal: Dorsoventral reversal of the graft is accompanied also according to the mode of union with diverse results. If the graft ventral epithelium is brought into complete union with the host dorsal epithelium, an elevation is formed with its margin represented by the line of union. Eyes are formed in the host dorsal epithelium. The inner surface of the cup-shaped region is lined with the graft ventral epithelium. In the specimen represented in fig. 14, eyes were formed in the host dorsal epithelium, one pair of them anterior and the other posterior to the graft ventral epithelium, while the old eyes of the graft themselves still remained, but were in the process of degeneration. Fig. 15 shows a specimen in which a graft with reversed dorsoventral orientation developed on the ventral side of the host, the dorsal epithelium of the former being surrounded by the ventral epithelium of its own and that of the latter. While the original left eye (*le*) had been left behind during the development of the graft, another left eye (*e*) was newly formed, constituting a pair with the original right eye (*re*), which was then brought forwards by the development of the graft. Similar results were obtained in many other cases. In fig. 16 is given a specimen in which after union of a graft in reversed dorsoventral orientation the anterior portion of the host was removed at the level of transplantation. A perfect head, though reversed, was formed by the graft itself, while none was regenerated from the host.



Figs. 11–13. Incomplete unions of a head piece in the prepharyngeal region; fig. 11, transplantation in the rectangular direction, union taking place only on the right side with the host dorsal epithelium, 25 days. Fig. 12, transplantation in oblique direction, 8 days. Fig. 13, in reversed orientation, 36 days in lateral view.

Figs. 14–16. Dorsoventrally reversed head pieces in the prepharyngeal region; fig. 14, 29 days. Fig. 15, graft grown out to the ventral side, 31 days. Fig. 16, regeneration inhibited on removal of the anterior part of the host, 80 days. *le*, *re* left and right eyes of the graft, *e* new eye.

Polarity reversal: Only in one among 28 cases, as the result of transplantation of the head piece, did polarity reversal at the time of regeneration occur on the anterior cut surface of the host. This is shown in fig. 17. On the 26th day after a head piece was united with the host, a cut was made on the latter just before the former (indicated in fig. 17a by a broken line). A tail, instead of a head, regenerated at the anterior end of the posterior large portion of the host which was in connection with the graft. This was followed even with the formation of a small pharynx (figs. 17 b, 18 *ph*). As the regeneration was in progress, the grafted head continued to grow dorsally and was finally cast off, the narrow portion of the peduncle becoming thinner and thinner. It remains, to our regret, still uncertain, whether, in the case in question, the regeneration of tail took place under the influence of the graft head, or whether, instead, a true heteromorphic tail regenerated because of polarity reversal on the part of the host itself.

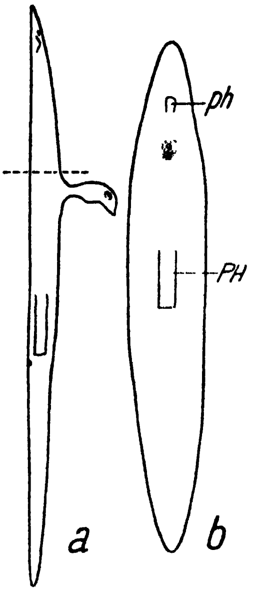


Fig. 17. Polarity reversal; a, head developed on the dorsal side of the prepharyngeal region as the result of transplantation of a head piece in anteroposteriorly reversed orientation, union incomplete, 26 days in lateral view. b, on removal of the anterior part of the host tail regenerated instead of head on the anterior cut surface, 79 days from the beginning in dorsal view. Grafted head has been cast off in the course of time, the position being indicated by dotted area close behind the new pharynx (*ph*).

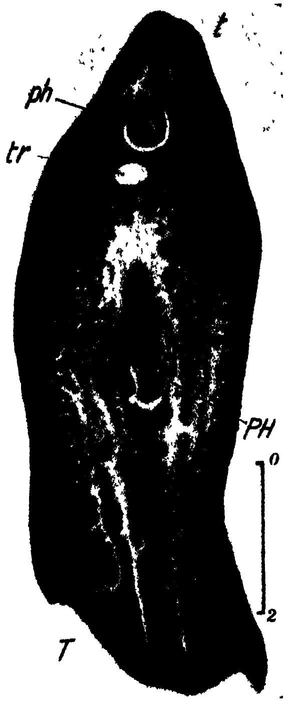


Fig. 18. Median horizontal section of the same specimen as in the preceding figure, showing the internal structure; *PH* old pharynx, *ph* new pharynx, *T* old tail, *t* new tail, *tr* position of transplantation.

Formation of new eyes: Formation of new eyes in planarians is, Goetsch (1921) says, only possible in newly regenerated regions, but not in old ones. Nevertheless, it does, beyond any question, often occur in the graft heads as well as in the host tissues in their neighbour, as indicated already in the preceding examples. Formation of new eyes, now, is closely associated with the change of axis which takes place in developing grafts. In the case shown in fig. 19, for example, the graft head united at first by the left cut surface with the host body grew gradually forwards, accompaning the host tissue, from the free end at the right (fig. 19 a). In fig. 19 b is indicated the state of the graft head on the 25th day after operation. Besides the original eyes *r* and *l* which were now situated anteroposteriorly, new eyes r_1 and l_1 were formed in symmetrical positions in relation to the longer axis that was newly set. The graft head continued to grow larger into a cylindrical form. After 10 days an eye (fig. 19 c, r_2) and a white area appeared between the anterior pair of eyes (*r* and r_1) and a few days later another new eye (l_3) on the outside of the old one (*r*). The cylindrical head which had then grown laterally to a considerable extent burst into a plane on the ventral surface from the right lateral corner which was in contact with the host, and the host head turned simultaneously to the left as indicated in fig. 16 d. Hence a T-shaped bicephalic form resulted. As stated above, if in a graft head of *Planaria gonocephala* change of polarity takes place before its development, regeneration that follows and, at least, formation of eyes are wholly under the control of the axis which is newly set: the original symmetrical relation to the old pair of eyes becomes abandoned, and eyes are formed in new positions symmetrical to each other. If during the development of the head the symmetrical relation is subjected to further anomaly, or if it is incomplete from the first, new eyes are formed once more in a new symmetrical relation and so on, regulation being continued until ultimate stability is reached.

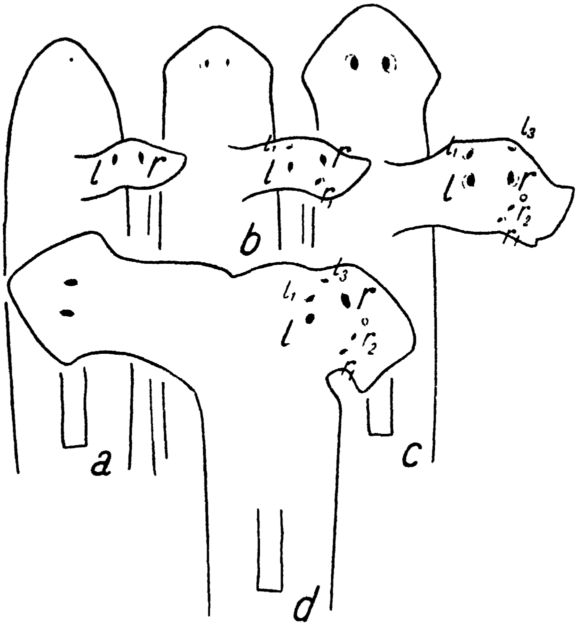


Fig. 19. Formation of extra eyes each time of changing direction in which the grafted head develops, transplantation being oblique and union taking place only on the left side of the graft; l old eye on the left side, r that on the right side, l_1, l_3 new eyes developed on the left side, r_1, r_2 those formed on the right side. a, 16 days; b, 25 days; c, 45 days; d, 51 days.

2. Transplantation of the ganglionic piece into the postpharyngeal region

In 5 out of 22 specimens, the graft was united merely with either the dorsal or the ventral epithelium of the host; the head developed therefrom was in connection with the host by a narrow peduncle, as in the cases of transplantation into the prepharyngeal region. It was cast off ultimately from the host in 2 specimens. In the remaining 3 cases also, which were fixed for the investigation of internal structures, the tendency of the head to be cast off was obvious. In these examples the influence of the graft was only recognized in a restricted region of the host in contact with the former, with nothing more worth mentioning.

In the transplantion of a head piece into the prepharyngeal region, resorption of the graft never takes place. Moreover, except in the preceding cases of imperfect union, two new pharynges are induced, so far as union is complete, in the old tissue of the host, one anterior and the other posterior to the level of transplantation, regardless of the orientation of the graft and no matter by which out of its four cut surfaces the graft is united with the host, as was already shown by SANTOS (1929, '31) with numerous examples. New tissue also appears around the graft. Though it is not yet quite clear, whether it is derived from the host or from the graft, it is in this region (post-pharyngeal) probably of the host origin. As an attempt to come nearer to the question, pieces stained *intra vitam* with a dilute aqueous solution of Nile blue sulphate were used as grafts, but they did not prove to be of any direct service for solving the question. The new tissue, in fact, was stained blue, but it does not necessarily follow from this that it was derived from the graft, for, on grafting a stained piece, diffusion of the dye by itself into the host tissues is evident at first sight. The experiments and their results are summarized in table II.

Table II

Transplantation of Ganglionic Piece into Postpharyngeal Region.

Experiments			Results						
			Normal Head			Heteromorphic Head		Production of Pharynx	
Mode of Union	Secondary Operation	Number	Plane	Dorsal Out-growth	Ventral Out-growth	Dorsal Out-growth	Ventral Out-growth	One	Two
Complete	Not performed	5				(2) Saccular	(3) Saccular		5
	Cut anteriorly	1	1					1	
	Cut posteriorly	5	5					5	
Partial Union	Not performed	6	2	2		2		1	4
Incomplete	Not performed	1					1		1
	Cut anteriorly	1				1		1	
	Cut posteriorly	3	1	1	1				

Cuts made at the level anterior or posterior to the graft after transplantation: After a head piece is transplanted with normal orientation into the post-pharyngeal region, if the host body is cut in front of the graft, the latter develops into a complete head, dominates over the more posterior regions and induces development of the pharynx to complete the normal organization of a worm. In fig. 20 is shown a specimen in which the graft had already induced a new pharynx in the host body before the cut was made. Fig. 20 c represents the completed individual consisting of the postpharyngeal region from the host, which was cut anteriorly to the graft level, and the graft head situated in front of it. Figs. 21, 22, 26, 28, 32, 34 and 35 are examples, in which by auto- or homoplastic transplantation of a head piece production of two pharynges opposite to each other was induced in the postpharyngeal region.

In these cases, no matter by which of the cut surfaces the graft was united with the host, the result of pharyngeal induction was always the same.

If the tail of the host is removed at a level posterior to the graft, a head appears in the opposite direction, with the induction of another pharynx in reversed orientation between the head and the host pharynx. Those cases which are represented in figs. 24, 25, 26, 29 and 30 belong to this category.

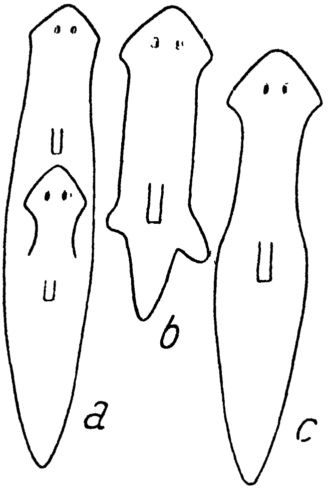


Fig. 20. a, 20 day old specimen with head graft in the postpharyngeal region in normal orientation; b, anterior, and c, posterior parts of the same specimen 18 days after transverse cut in front of the graft.

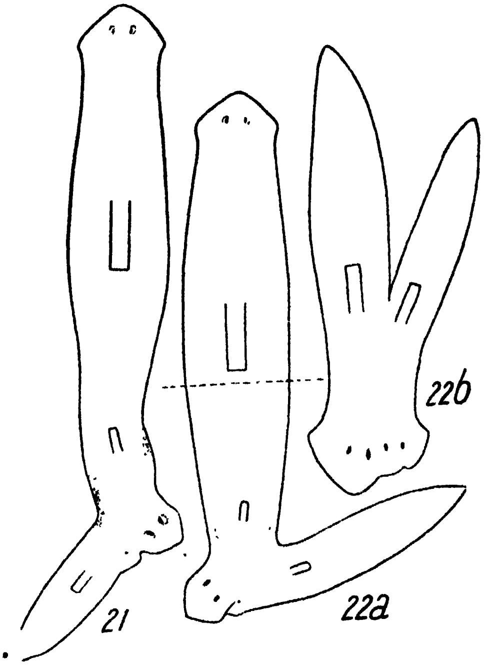


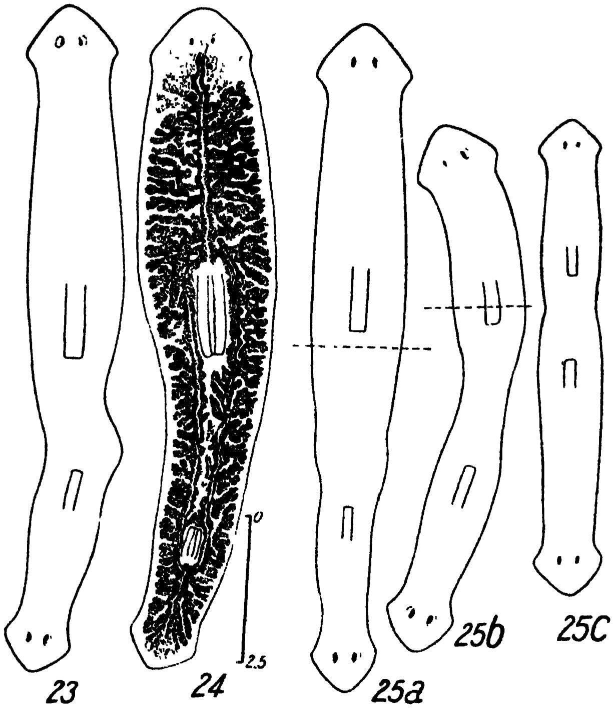
Fig. 21-22. Transplantations of a head piece into the postpharyngeal region in reversed orientation; fig. 21, union complete, 16 days. Fig. 22 a, similar to the preceding, 20 days; b, tail regenerated to the anterior side of the posterior part cut separated behind the pharynx at the level of a dotted line in fig. 22 a, 105 days from the beginning.

If a cut is made in these specimens at a level somewhat posterior to the host pharynx, in most cases a tail, instead of a head, regenerates from the anterior cut surface of the posterior part (figs. 22 b, 33, 35 c).

In figs. 21 and 22 are represented two examples in which, after the graft was united by its posterior end with the host, new tissue appeared between them and an extra head was formed also from the host. When a cut was made at such a level as shown by a broken line in fig. 22 a, a tail regenerated from the anterior cut surface of the posterior part (fig. 22 b). Thus in transplantation of a head piece, reversal of polarity had evidently occurred at a portion of the old tissue of the host.

In fig. 23 is represented a case in which after union of the graft that portion of the host body which was posterior to the graft was cut off, and in which after 9 days the anlage of the new pharynx already made its appearance. Fig. 24 is a sketch from a mounted specimen, which was operated in the same way and was fed with chick liver stained with carmine before fixation, to show the state of intestinal branching. Here, the existence of common posterior branches of the intestine between the old and the new pharynges can evidently be observed.

Fig. 25 shows a specimen, of which the anterior portion was cut off, after the posterior head and the second pharynx were induced by transplantation of a head piece at a level just behind the host pharynx (a), with the subsequent regeneration of a head at the anterior end. When a cut was made again afterwards on a plane through the new host pharynx (b), a head was regenerated as before and a pharynx, too, was formed once more. This specimen decreased in size, as time passed, and the two pharynges (one regenerated and the other induced in the reversed direction by the graft) drew nearer to each other.



Figs. 23–25. Posterior exstirpations in the postpharyngeal transplantation of a head piece in reversed orientation; fig. 23, 35 days. Fig. 24, showing the intestinal branching in a mounted specimen. Fig. 25 a, transverse cut just behind the pharynx, 22 days after producing a posterior head; b, head regenerated, cut was made once again through the pharyngeal level after 25 days; c, head again regenerated, 131 days from the beginning.

Now, a case (fig. 26) happened, in which removal of the host head simultaneously with transplantation of a head piece was followed by the regeneration of an abnormal head with a single eye. An attempt was made to remove this head end. The cut surface was healed over and no regeneration took place. When this specimen was cut again after 20 days at a level just before the host pharynx, regeneration of the anterior part failed to occur as before. Further, at the place of transplantation the eyes of the grafted head were embedded in the tissue and new eyes appeared on the surface (fig. 26 a). Later on, separation from each other of the anterior and the posterior parts occurred at the level of transplantation. The anterior one was cut into sections and examined. It was observed, as indicated in figs. 26 and 27, that two pharynges opposite in direction were piled up one upon the other, the reversed (*ph*) above and the normal (*PH*) below. Moreover, at the anterior end of the piece lateral nerve-cords on both sides were connected together, and the intestine, from the posterior heteromorphic head to the pharynx, was full of cell débris. By the way, the worm was put previous to fixation into a suspension of carmine particles to study the ciliary movements on the body surface. Particles were observed to move backwards at the regions anterior to the middle of the pharynx, while they moved forwards at the more posterior regions.

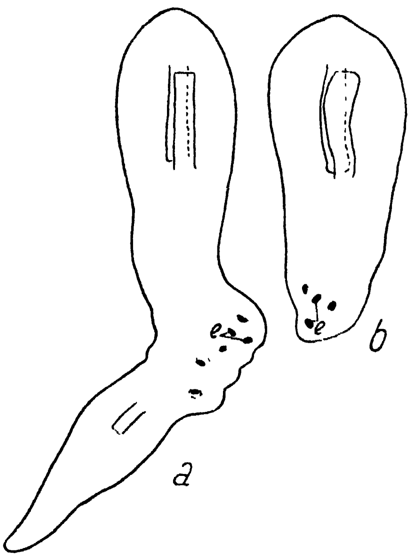


Fig. 26. a, Head formation inhibited on the anterior side of the specimen with a head graft in the postpharyngeal region when cut was made in the prepharyngeal level, 152 days after transplantation; b, anterior part which was separated off. Notice the presence of two pharynges one upon another in a common sheath. *e* old eyes.

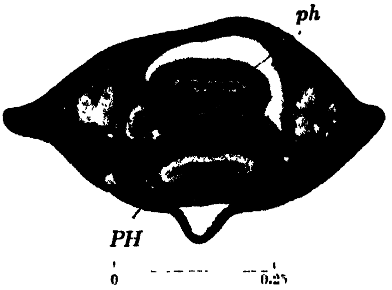
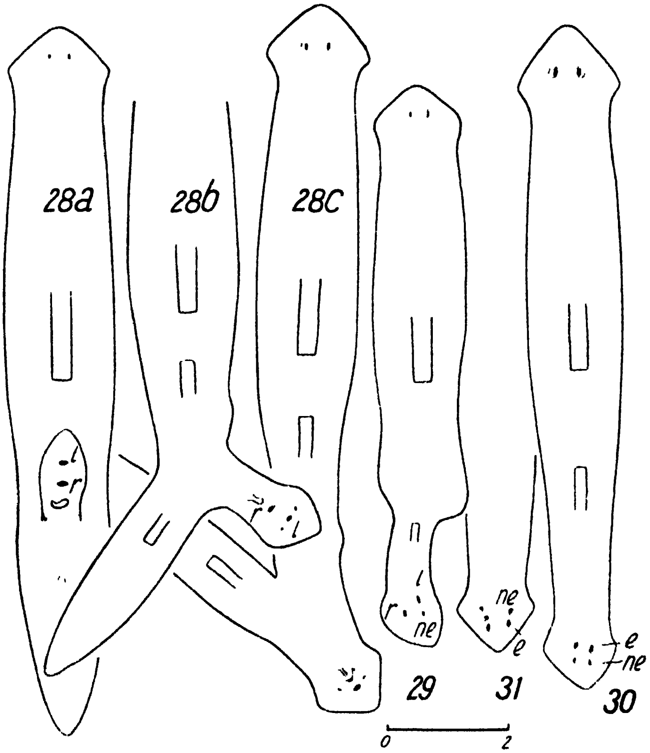


Fig. 27. Transverse section of the double pharynx in fig. 26.

Formation of supernumerary eyes: We described already some cases of transplantation of a head piece into the prepharyngeal region, where besides the original eyes of the graft one to several eyes were formed. Also in the cases of transplantation of a similar head piece into the postpharyngeal region, formation of extra eyes occurred, depending upon which portion of the graft remained free and in what manner of union with the host. That change of axis had occurred in the graft could safely be inferred from this. In the case of fig. 28 in which the graft was transplanted in transverse direction into the host, union taking place merely on the anterior and the posterior cut surfaces, the graft began to develop from the free cut surface on the left side, i. e. from that portion directed forwards, and gradually lengthened in a direction at right angles to the host body (fig. 28 a). Concurrently a pair of eyes appeared on both sides of the original left (*l*), i. e. the anterior median eye (fig. 28 b), and somewhat later another pair of eyes on both sides of the original right (*r*), i. e. the posterior median eye, besides an extra eye on the right of the anterior median eye (fig. 28 c). In the case under consideration the head developed from the graft has turned during the development about 90° from the original direction. But structures of the head other than the eyes differed in no way from those of normal worms.

In fig. 29 is represented a case in which a head piece was grafted into the host somewhat obliquely to the longer axis. After development of the graft head, a new left eye was formed in front of the original one, constituting a pair with the right eye which was now situated more anteriorly.

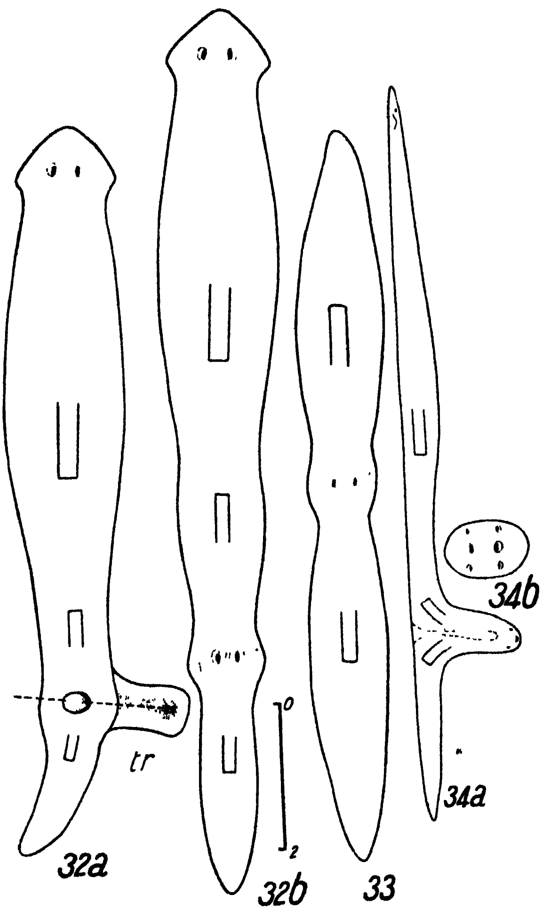


Figs. 28-31. Development of supernumerary eyes relating to the change of axis in growing head. Fig. 28, transplantation of a head piece into the postpharyngeal region in transverse direction, union taking place on lateral sides, while anterior and posterior sides remained free; a, head grown out in the anterior direction, 30 days; b, head turned to lateral side, two pharynges have been induced and new eye appears to the anterior median eye (*l*), 48 days; c, 5 extra eyes are formed besides the two old ones (*l* and *r*), 81 days. Fig. 29, posterior part of the host was removed in a similar transplantation of the head piece in reversed orientation. Head with 3 eyes resulted owing to obliqueness of the original transplantation, 14 days from the second operation. Fig. 30, Removal of the posterior part of the host after transplantation of a head piece in normal orientation, with the result of an appearance of pair of eyes in front of the old ones, 70 days. Fig. 31, New eyes appeared behind (front in figure) instead of before as in the preceding case; *e* old eyes, *ne* new eyes.

In the case of fig. 30, a head piece was grafted into the same individual in normal orientation in the middle of the postpharyngeal region, and after union took place the tail was cut off, leaving the graft in connection with the main part of the body. As the result the posterior cut surface of the graft was exposed again, new tissue appeared in a small quantity, and a head in reversed orientation was formed. Meanwhile, posteriorly (or anteriorly, if the regenerated head be taken as a landmark) to the pair of old eyes (*e*) another additional pair of new eyes (*ne*) appeared. Though in this case the head newly formed and directed backwards is reversed in relation to the original axis of the graft piece, it is quite normal in shape. If it is taken into consideration that, so far as formation of eyes is concerned, those original to the graft are abandoned and new ones are formed, we are led to a position that the formation of the head in question probably represents regeneration of a head heteropolar to and independent of the graft one.

In fig. 31 is represented a head which was regenerated in an experiment similar to the preceding one on the posterior cut surface of the host whose tail was cut off on the 9th day of transplantation. As in this case the host tail was cut behind the original pair of eyes and very close to these, regeneration was not accompanied with the formation of new tissue. Consequently, after the head was completed, the eyes were found too anterior in position in comparison with the normal. It means probably a correction to this that anterior (or posterior, if the regenerated head be taken as a landmark) to them three supplementary eyes (*ne*) were newly formed in the host tissue. Here, formation of supernumerary eyes took place behind, instead of before, as contrasted with the preceding case.

In the above cases also, development of a new pharynx was induced in the reversed direction at a level in front of the grafted head, as in the other cases already considered. In the case of fig. 28, moreover, two pharynges in opposite direction appeared, one anterior and the other posterior to the level of transplantation.



Figs. 32–34. Transplantations of a head piece into the postpharyngeal region in reversed orientation and union complete; fig. 32 a, the grown-up transplant projects on the ventral side like a pocket and two pharynges are induced, one before and other behind, 50 days, b, when the project is cut open (on 78th day from beginning), head comes out and flattens in a plane. In the specimen of fig. 33, anterior part of the host was cut off behind the pharynx and tail instead of head regenerated from the posterior part bearing the graft, 68 days. Fig. 34, in the same transplantation as before the graft projects on the dorsal side, a, 20 days in lateral view; b, dorsal view of the grafted head, with 4 new eyes in 2 pairs beside 2 old ones.

Cases without subsequent cut: Figs. 32, 33 and 34 represent cases of complete union of the graft with the host. Fig. 32 is the result of a head piece transplanted in reversed orientation, while figs. 33 and 34 are those in normal orientation. In two of these cases an outgrowth occurred on the ventral surface and a corresponding invagination on the dorsal. The graft head was then brought again into the same plane as the host body by the operation on both sides of the graft level, as indicated by broken lines in fig. 32 a, and the result as shown in fig. 32 b was obtained. Further, in the specimen of fig. 33 the anterior part was cut off at a level just behind the host pharynx, with the subsequent production of a tail in the reversed direction. Fig. 34 is the case in which the graft projected on the dorsal surface and two pairs of eyes were formed, one before and the other behind the graft pair (fig. 34 b). In the above cases, regardless of the orientation of the head graft, its influence on the host body was always the same, two pharynges in opposite direction being induced before and behind it.

Incomplete union: When union was incomplete and a part of the graft remained free, the latter grew up cylindrically accompanying the host tissue as

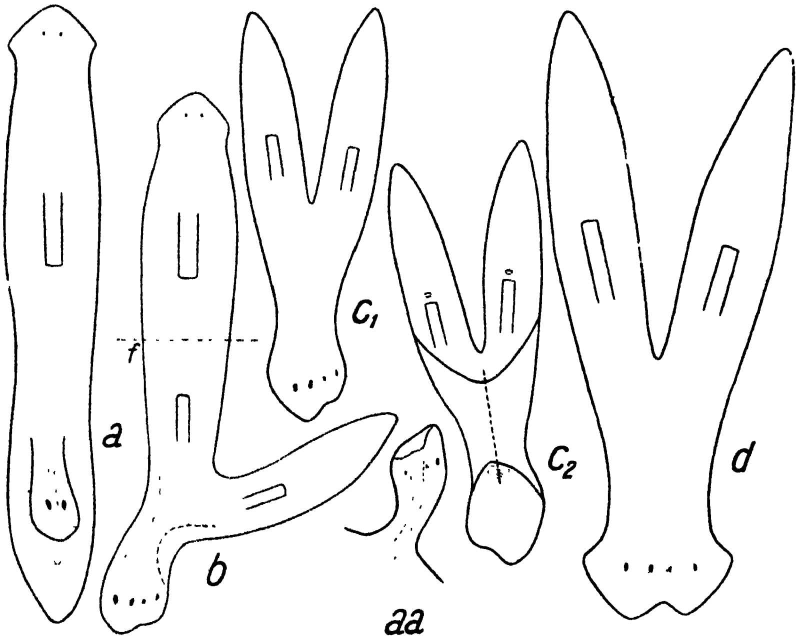


Fig. 35. Polarity reversal due to the transplantation of a head piece into the post-pharyngeal region in reversed orientation; a, dorsal view of the entire animal with the head graft grown-up cylindrically on the dorsal side, 28 days; aa, lateral view of the head alone; b, fission took place at the level of a broken line on 40th day; c, tail regenerated to the anterior side of the posterior part bearing the graft, 8 days after fission, c_1, dorsal and c_2, ventral view; d, after cutting open the cylindrical head on the ventral side, an animal with two heads and two tails resulted, 56 days from the beginning. Compare this figure with fig. 22 b.

in the cases of transplantation into the prepharyngeal region. A typical example of such a case is illustrated in fig. 35, a being a sketch of 28 day old specimen. In fig. 35 aa is represented the graft head with two supernumerary eyes of the same specimen, which is seen from the right side. After about 40 days from the first operation, fission took place at about the middle between the host pharynx and the induced one (indicated by a broken line in fig. 35 b), and a tail developed from the plane of fission (fig. 35 c_1). The ventral surface of the cylindrical head was cut open longitudinally at about the same time (c_2), and a worm with two heads and two tails appeared as shown in fig. 35 d.

To sum up the results of experiments so far as described of transplantations in *Planaria gonocephala*, a head piece, in whatever region of the body and in whatever orientation it may be grafted, always gives rise to a head. If the graft piece is united incompletely with the host body, heads from the normal to the extremely abnormal with transitional forms of various degrees can be formed; particularly, when the former is united merely with either the dorsal or the ventral epithelium of the latter, it develops into a funnel-like or a goblet-like head. And the portion connecting the graft and the host forms a cylindrical peduncle (the so-called postcephalic outgrowth of SANTOS). The peduncle is covered with the host epithelium of that side which is united with the graft. In these cases, though graft and host may unite with epithelia of different sorts, it can never happen that either the dorsal or the ventral epithelium takes over the character and the structure of the other, as already shown by L. V. MORGAN (1906) as well as by SANTOS (1931). This peculiarity of the epithelia may also be a cause for varying forms of the head produced according to different modes of union between the graft and the host.

If graft and host are united by epithelia of the same sort and a part of the graft is left free, it becomes the anterior end of the new head, no matter in what orientation and into what level of the host it may be grafted; and if the greater part of the graft is left free, the anterior end of the new head appears at the situation farthest from the point of union. Here accompanied with the change of axis in the piece, new eyes develop in relation to the new axis. Thus a close enquiry into the topographical relations between the old and the new eyes will readily reveal the course of development of the graft head.

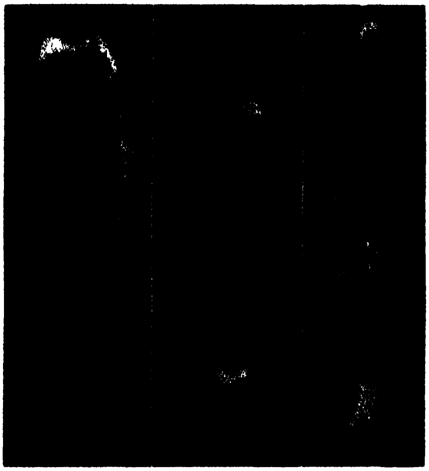
The influence of the graft on the host is different according to the degree of union as well as according to the level of transplantation; so far as they are united by epithelia of the same sort, no matter on which one of the cut surfaces, anterior or posterior, right or left, the graft may unite with the host, always similar influence is exercised on the host. When union is complete, if a cut is made anterior to the graft, the graft develops into a head for the host body posterior to that level; and if a cut is made posterior to the graft, a head is formed in the reversed direction. In the latter case if the graft is transplanted in the postpharyngeal region, the development of a new pharynx is induced in front of the head. Here if the host tail is not cut and left untouched, the development of two new pharynges, one anterior and the other posterior, is induced.

When the union is incomplete between the graft and the host, an outgrowth of a part of the latter is effected by an extension of the former, and a peduncle is formed. Here takes place scarcely any formation of new tissue. On the contrary, when the union is complete between the graft and the host, formation of new tissue always occurs, though different in quantity according to the level of transplantation. It is always between the new tissue of this sort and the old tissue of the host that a pharynx is formed in transplantation of a head piece into the postpharyngeal region. The new tissue is supposed to have been derived from the host by the influence of the graft; it represents a postcephalic region for the graft head and a prepharyngeal region for the host.

3. Transplantation of the preocular piece

Transplantations were successful only in 5 cases, of which 4 were those into the prepharyngeal region and one that into the postpharyngeal region. But the results were almost identical. When a graft piece was transplanted into the prepharyngeal region and union was complete, if the host body anterior to it was removed, it always developed into a head (figs. 36, 37). In a case where union was incomplete owing to the lack of connection between the ventral epithelium of the graft and that of the host, the graft developed dorsally accompanying some of the host tissue into a funnel-shaped head, while another head regenerated from the cut surface (fig. 39).

In a case of postpharyngeal autoplastic transplantation, on removal of the host tail posterior to the graft piece, a head developed in the reversed direction as in the case of transplantation of a head piece. New tissue was formed along the line of union between the graft and the host, and a pharynx in reversed orientation was also induced at a level in front of the head (fig. 38). The new head was far smaller than the normal, though it was complete in morphology.



36 37 38

Figs. 36-37. Results of transplantation of a piece anterior to the ocular level into the prepharyngeal region and subsequent removal of the host part preceding it; a, homoplastic, 16 days; b, autoplastic, 17 days after the first operation.

Fig. 38. Transplanted into the postpharyngeal region and posterior part of the host removed, 23 days.

4. Transplantation of the auricular piece

All 3 cases that will be mentioned are autoplastic transplantation of the piece into the postpharyngeal region. In the case of fig. 40 a, the host body posterior to the level of transplantation was removed, and the state of regeneration on the 7th day of operation is represented. A complete head was formed after 63 days (fig. 40 b). In the case of fig. 41, a tail regenerated from the cut surface of the host and in contact with the graft, while the graft itself developed likewise into a complete head and induced a pharynx in the outgrowth from the host. In the third case represented in fig. 42, in contrast with the two preceding cases, neither eye nor pharynx was formed by the grafting. But the part drawn out by the graft could never be considered to be provided with tail characters, and the tissue of this part could not be thought to have been assimilated by the host, since a small pore considered as a mouth appeared on the median line on the ventral surface. But a pharynx was not formed after all.

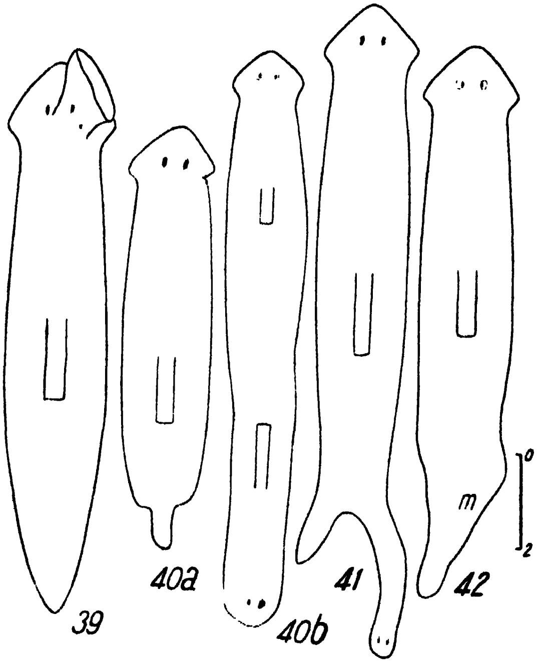


Fig. 39. Incomplete union of a preocular graft with the prepharyngeal region.

Figs. 40–42. Autoplastic transplantations of an auricular piece into the postpharyngeal region and subsequent removal of the host part posterior to it; fig. 40 a, 7 days; b, 63 days, during which anterior part of the host including the pharynx removed and regenerated. Fig. 41, in a similar transplantation, tail regenerated besides head, 63 days. Fig. 42, case in which neither head nor tail formed, but mouth (*m*) opens at the base of the elongated graft.

B. Prepharyngeal Grafts

In the middle of the part situated before the pharynx, a rectangular piece which was of approximately the same size as or somewhat larger than that which was employed in the experiments of head grafts was cut out (cf. fig. 1 a). It was rotated anteroposteriorly in the same place or transplanted in normal or reversed orientation into the pre- or the postpharyngeal region of the same or another individual. In this series of experiments also, the host body in most cases was cut after transplantation at a level anterior or posterior to the graft.

5. Rotation and transplantation in the same place

Rotation experiments were repeated 21 times. In 17 cases out of them the piece was placed in normal dorsoventral orientation and the union took place between the host and the graft on both dorsal and ventral sides by the respective epithelia. And up to 16 cases of this series of experiments the original head was cut off at a level anterior to the graft. As the result a normal head was regenerated in 13 cases, while in two of the remaining cases an abnormal head was formed and in the third regeneration was inhibited. In one specimen in which a secondary cut was not made, the rotated area was merely slightly elevated. The experiments and their results are summarized in table III.

Table III

Rotation of Small Area at Prepharyngeal Level.

Experiments			Results			
Mode of Implantation	Secondary Operation	Number	Regeneration of Normal Head	Regeneration of Heteromorphic Head	Regeneration of Tail	Regeneration inhibited
Normal Dorsoventral Orientation	Not performed	1				
	Cut anteriorly	16[*]	13	2		1
	Cut posteriorly	1			1	
Reversed Dorsoventral Orientation	Cut anteriorly	3		2[△]		

[*] In one among these cases union was incomplete.

[△] In one remaining case an indifferent form resulted.

In the cases where the rotated piece was brought into complete union with the main body, if the part anterior to it was removed, a head, notwithstanding the anteroposterior rotation of the piece, was always regenerated on the cut surface, i. e. the original posterior side. Fig. 43 represents a typical case. In these cases the new head was formed usually by the cooperation of the rotated piece and the tissue on both sides of it. In one case only the head was formed by the tissue solely of the small piece. Fig. 44 shows a case in which the worm was cut posteriorly to the rotated area. Here a tail regenerated on the cut surface, i. e. the original anterior side.

In the case of fig. 45 where union was incomplete, the posterior end of the rotated portion, i. e. the original anterior side did not come to be united with the main body. Hence a head regenerated therefrom and at the same time the head which had been removed regenerated. Generally speaking, rotated pieces can be united easily and completely; incomplete union, as in the case under consideration, is extremely rare, being met with only once during the whole course of our experiments. At any rate, it serves us sufficiently for a demonstration that, if the original cut surface of the rotated piece is exposed, a head is regenerated therefrom.

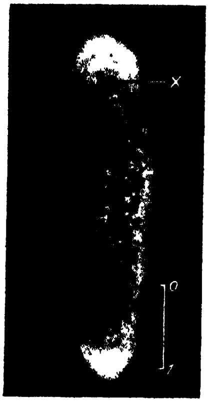
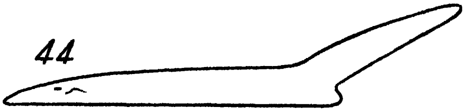
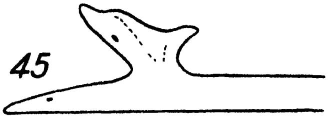


Fig. 43. Result of the anteroposterior rotation of a small area in the middle of the prepharyngeal region (indicated by ×), followed by anterior cut, 16 days.





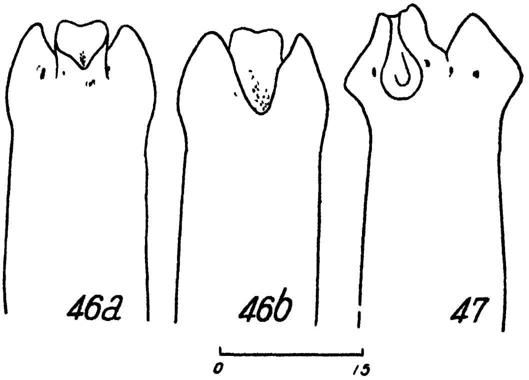


Fig. 44. Posterior removal to the rotated area in the prepharyngeal region, 23 days.

Fig. 45. Head regenerated in the rotated area of incomplete union, 32 days.

Figs. 46–47. Rotated area is dorsoventrally reversed; fig. 46, 71 days after the anterior removal, a, dorsal, b, ventral view. Fig. 47, 57 days.

Figs. 46 and 47 are the results of union of a rotated piece in reversed dorsoventral orientation with the main body, of which the head was subsequently removed. In these cases the reversed ventral epithelium formed an invagination, which became surrounded by the dorsal epithelium in cooperation with that of the main body. In the case of fig. 46, on each side of the rotated piece an incomplete head was formed, each provided with an eye, and on the dorsal epithelium surrounding the invagination of the reversed area, also, two small eyes were formed. In the case of fig. 47 also, the ventral epithelium of the reversed area formed an invagination. But, as the dorsal epithelium on migration became connected with the dorsal epithelium of the main body, the head developed from the graft (rotated piece) and the one regenerated from the left anterior cut surface of the host (main body) came, as it were, to embrace each other, the reversed ventral epithelium intervening between them, and, on the other hand, a more or less complete head developed from the right anterior end of the host. Further, the ventral epithelium of the reverted graft formed a narrow bandlike portion and connected itself with the ventral epithelium of the host. As demonstrated by the two preceding cases, in replacement of the rotated piece with their dorsiventrality reversed the graft never develops into a complete head in cooperation with the main body. This is due to the fact that the dorsal and the ventral epithelia are, as we have already seen, specialized to a considerable degree. By the way, it also depends on these differences of properties between the dorsal and the ventral epithelia that, when they are united, an outgrowth is always formed, of which the boundary is represented by the line of union.

As a control to the experiments of rotation, the prepharyngeal piece was transplanted with either normal or reversed orientation into a similar position of another worm. The results were literally the same as those in the preceding experiments, and on removal of the anterior part of the host body, further development gave rise to a worm identical with a normal one.

6. Transplantation of the prepharyngeal piece into the postpharyngeal region

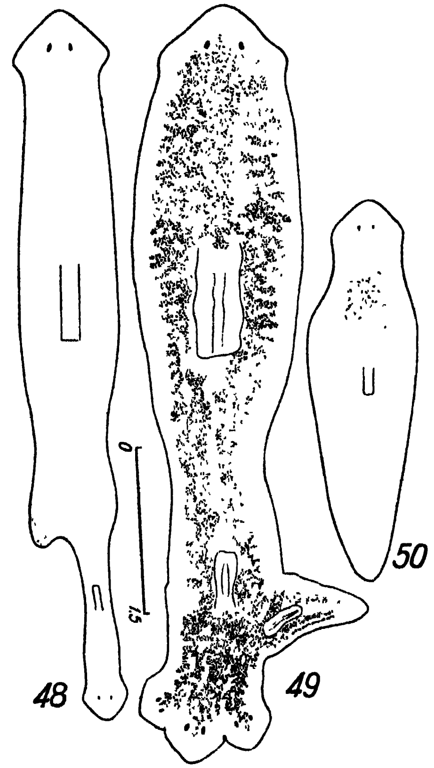
The experiments and their results are summarized in table IV. In 9 out of 20 successful cases the graft piece was united in normal and in the remaining cases, in reversed orientation. In the transplantation with normal orientation, if the host tail was cut off at a level posterior to the graft, a head developed from the cut surface (the original posterior end of the graft) (figs. 51, 52), with only one exception to the rule. Nevertheless, in this case too, a pharynx

Table IV

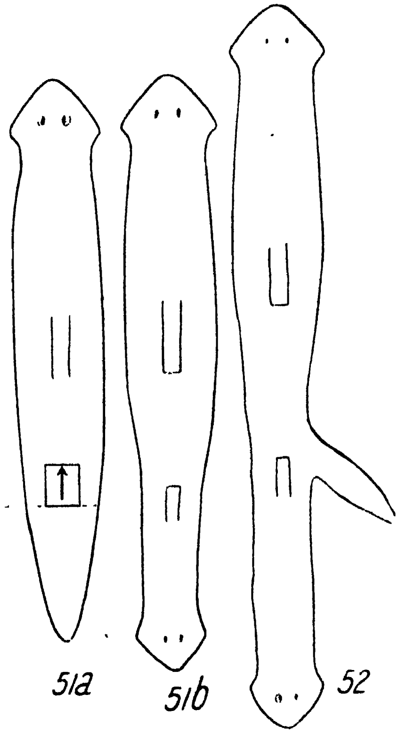
Transplantation of Prepharyngeal Piece into Postpharyngeal Region.

Experiments			Results			
Mode of Union	Secondary Operation	Number	Regeneration of Head	Induction of Pharynx		
				One	Two	None
Complete Union in Normal Orientation	Not performed	3			3	
	Cut posteriorly	4	3	4		
Complete Union in reversed Orientation	Not performed	4			3	1
	Cut anteriorly	3	3	3		
	Cut posteriorly	2	2	2		
Normal Orientation (Union at Anterior Cut Surface of Graft)		1	1 (From Posterior Cut Surface)			
Normal Orientation (Union at Posterior Cut Surface of Graft)		1	1 (From Anterior Cut Surface)			
Incomplete Union in Reversed Orientation		2	In both cases head was formed along line of union of two components			

developed in the reversed direction without any formation of the tail (fig. 53). There was also a case with the graft in reversed orientation, in which on removal of the anterior part of the host, a head was formed from the anterior cut surface, i. e. the original posterior end of the graft (fig. 50). In two other cases with incomplete union with the host, the graft migrated after the cut concurrently with the extension of the host tissue; a new head developed from the line of union of the two components and a tail from the original posterior end of the graft.



Figs. 48–49. Transplantations of a prepharyngeal piece into the postpharyngeal region in reversed orientation and subsequent removal of the posterior part of the host; in fig. 48 head regenerated to the posterior side and pharynx appeared in the new tissue, 21 days. Fig. 49. 3 heads are formed to the posterior or originally the anterior side of the transplant and tail to the right side from the posterior cut surface of the host, 60 days. Fig. 50. In the same transplantation as before, anterior part of the host removed; head regenerated to the anterior or originally the posterior side of the graft, 8 days after transverse cut.



Figs. 51–52. Transplantations of a prepharyngeal piece into the postpharyngeal region in normal orientation and removal of the host posterior part; fig. 51 a, showing the method of operation (grafting and subsequent cut); b, result of 40 days, head regenerated from the posterior cut surface which is also posterior to the graft. In fig. 52 tail regenerated in addition to the right side from the host 49 days.

There were 7 cases in which a cut was not made after transplantation. So far as the union was complete, no head was formed from the graft. Nevertheless, except in one case among them, two pharynges were induced, one anterior and the other posterior to the level of transplantation (figs. 54, 55, 57). In two other cases with incomplete union, a head developed in one and a tail in the other case. In the three remaining cases, after removal of the host tail a head was formed on the original anterior cut surface of the graft. Somewhat more precise explanations for individual cases will be given in the following lines.

In the cases of figs. 48 and 49 in which the graft was transplanted in reversed orientation with the subsequent removal of the host tail, one head in the former and three in the latter case developed from the posterior cut surface. In the case of fig. 48, a pharynx in reversed direction was formed in the new tissue induced by the graft; and in the case of fig. 49, a tail developed from the host tissue to the right of the cut, and a pharynx developed also in this tail, besides the one of the same significance as in the preceding case. In this specimen, moreover, three heads were formed, as mentioned, from the original anterior end of the graft in cooperation with the tissue at the posterior end of the host.

In the case of figs. 51 and 52, after a prepharyngeal piece was transplanted in normal orientation and the host tail was cut, a head was formed on the cut surface (the posterior end of the graft). In the case shown in fig. 53, a similar operation as in the two preceding cases was performed, and yet no head was regenerated from the graft. But the fact that a pharynx in reversed direction was induced suggests the possibility that the polarity of the tissue had been reversed.

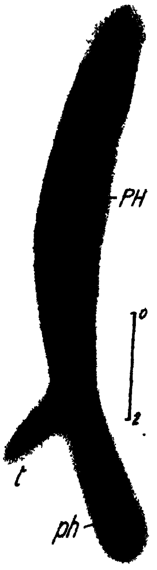
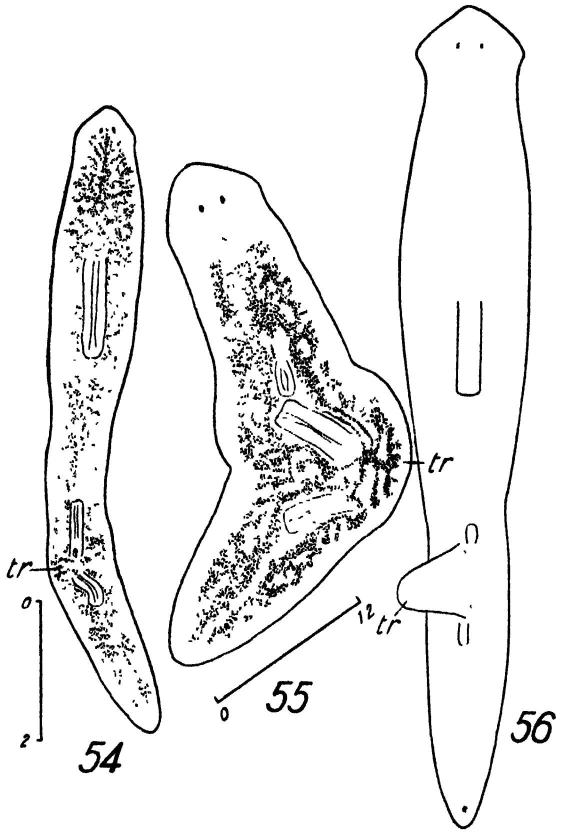


Fig. 53. In the same operation as before, head regeneration inhibited but pharynx (*ph*) formed anterior to the graft in reversed direction, 20 days.

7. Development of pharynx induced by the transplantation of a prepharyngeal piece

As can be seen from the preceding cases, if a prepharyngeal piece be transplanted into the postpharyngeal level and if its end, anterior or posterior, be exposed for the second time by a subsequent cut, head regeneration always occurs regardless of the orientation of the graft, and the development of a pharynx is followed in approximately the same relation as in the transplantation of a head piece including the brain. That is to say, in those cases in which union is complete and no secondary cut is made, though no head develops from the graft and only an elevation instead is formed there, two pharynges in opposite directions are induced to develop anteriorly and posteriorly to that level (figs. 54, 55, 56, 57). In the case of fig. 55, as the worm after transplantation of a prepharyngeal piece was divided into two by a cut just behind the host pharynx, the head at the anterior end was still small and regeneration of the pharynx also incomplete. Fig. 57 is a longitudinal section to show the elevation formed at the level of transplantation and the two pharynges induced. In fig. 58 is shown the photographic view of another specimen similar to the preceding. Fig. 56 represents a case in which the graft did not unite completely with the host and a portion of the former remained free, from which regeneration of a head was anticipated. But here, previous to the head formation, two pharynges already made their appearance, one anterior and the other posterior to that level. Examination of serial sections of the specimens of figs. 55 and 57 revealed, furthermore, no development of a structure at the level of the graft, which may correspond to or may, at least, be interpreted as a brain.



Figs. 54–56. Development of two pharynges, one anterior and other posterior, to a prepharyngeal graft in the postpharyngeal region; fig. 54, 23 days, from the mounted specimen. Fig. 55, in this example, the anterior part of the host is recently regenerated and the most anterior pharynx is shown far smaller than others which are induced, 54 days, from the mounted specimen. Fig. 56, in this case the left side of the graft left free and yet two pharynges are induced before head appears to the latter, 24 days; *tr* transplant.

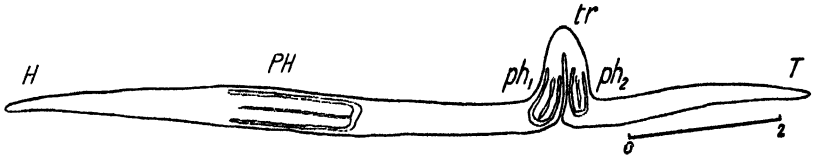


Fig. 57. Median longitudinal section of a specimen bearing two pharynges, one anterior (ph_1) and other posterior (ph_2) to the prepharyngeal graft (*tr*) in the postpharyngeal region, 22 days; *H* head, *PH* old pharynx, *T* tail of host.

Thus the influence on the host of the prepharyngeal grafts transplanted into the postpharyngeal region is, though accompanied with no development of brain, nearly the same in quality as that of the head grafts. The only differences observed between the two cases are as follows. In the case of prepharyngeal graft, when union is complete no head is formed, and when union is incomplete a head is formed through the normal course of regeneration, whereas in the case of head graft the graft by itself develops into a head, etc. But the degree of the effect on the host exerted by the graft is so different between the two cases that it is clearly indicated by the distance between the level of transplantation and the induced pharynx. That is to say, the distance between the two is far greater in the case of head graft than in the case of prepharyngeal graft.

Fig. 58. Photographic representation of the same transplantation as before. Notice the high dorsal elevation at the grafted area, 40 days.

C. Pharyngeal Grafts

To what extent in the body of planarians, then, is distributed the potency which, when a piece from different levels of the body is transplanted into the heterotopic region, induces the development of pharynx? But instead of replying to this question directly, rectangular pieces were cut out from different levels of the pharyngeal region, i. e. just in front, at the base and in the middle of the region, and experiments which were similar to the preceding were carried out.

8. Transplantation of the piece just before the pharynx

Transplantation into the prepharyngeal region: Union was complete in 10 out of 13 successful cases and incomplete in the remaining 3 cases. In 9 cases among the former, the graft was transplanted in normal orientation, direction of union being unknown in a remaining case. Pharynx developed in the graft in the 7 cases of complete union with normal orientation of the graft and in that case of unknown direction. One of these cases fig. 59 will be described as an example. By the operation new tissue was derived in a small quantity around the graft, and to the posterior of it, after 29 days, a mouth was observed to be open on the ventral surface between the graft and the new tissue. After still 28 days had passed, the worm was fixed and when cleared, a pharynx was detected well developed in the graft (fig. 59 *ph*). (In a specimen kept in water between 20-25°C. results similar to the above were reached in about 20 days). The new tissue which appeared around the graft was somewhat larger in quantity before the graft than behind it.

In the cases of incomplete union the results were complicated as shown in figs. 60–62. Thus in the case of fig. 60 in which the lateral surface of the graft united with the dorsal surface of the host, a small crescent-shaped imperfect worm resulted, of which the head with a single eye was derived from the anterior and the tail from the posterior cut surface. In the specimen shown in fig. 61, the ventral epithelium of the graft was surrounded by dorsal epithelia of its own and of the host, and thus a horn-like project with a slender peduncle was formed. In the specimen of fig. 62, as the graft united merely by the anterior cut surface with the host and the lateral as well as the posterior cut surfaces were left free, a tail regenerated from the posterior end of the graft, with a pharynx in the graft itself. On the other hand, a head regenerated from the wound surface of the host.

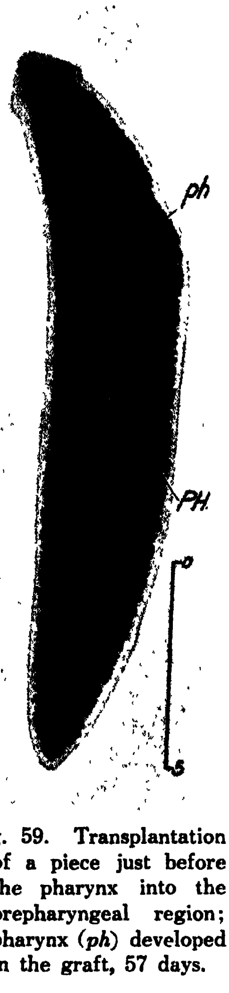
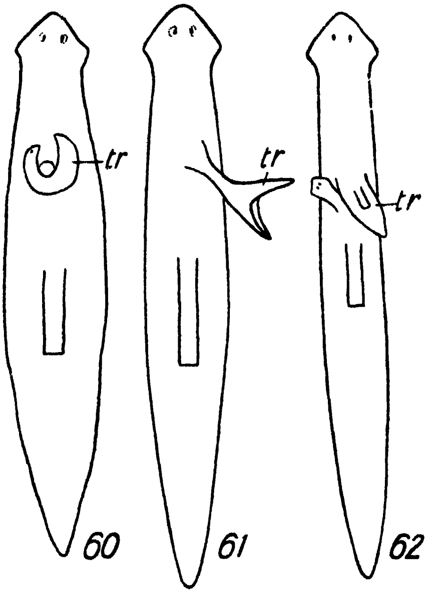


Fig. 59. Transplantation of a piece just before the pharynx into the prepharyngeal region; pharynx (*ph*) developed in the graft, 57 days.



Figs. 60–62. Cases of incomplete union in the same transplantation as before; in fig. 60, graft itself developed into an individual having median eye, 35 days; fig. 61, teratoform bearing the ventral epithelium of the graft on the upper side, 22 days; in fig. 62, posterior part only regenerated from the graft, 10 days.

Transplantation into the postpharyngeal region: Of 4 cases in which a piece similar to that used before was brought into the postpharyngeal region of another worm, the first example (fig. 63) represents a transplantation with reversed orientation of the graft. When, after operation, the host tail was removed, the cut surface was healed over and neither head nor tail regenerated. Considerable elongation, however, took place at the level between the graft and the host. Afterwards fission of the worm occurred at the level indicated by a broken line in fig. 63 a. Still later when the head was about to be regenerated in the posterior partner of fission, a cut was made again through the graft that remained at the posterior end of the new worm, as shown by a broken line in fig. 63 b. As the result a normal head here developed with a pharynx anterior to it in the reversed direction (fig. 63 c). The polarity of this region had probably been reversed, though to a slight degree, by the first grafting. But the influence of such a degree had probably not sufficed either to cause a head to develop at the posterior end or to induce a pharynx.

In three other cases in which the graft was placed in normal orientation and no cut was made as the second operation, merely an elevation slightly above the host dorsal surface resulted at the level of transplantation. In one case, however, a pharynx was evidently formed in the graft (fig. 64).

9. Transplantation of the pharyngeal basis

Next followed transplantation of a small piece including the pharyngeal basis (cf. fig. 1 a, *ph.b*). Three successful cases were obtained in the prepharyngeal as well as in the postpharyngeal region respectively.

Transplantation into the prepharyngeal region: In fig. 65 is represented a case with the graft in normal orientation, in which besides the pharynx that was transplanted (ph_1) one more pharynx developed in the graft (ph_2). In fig. 67 is indicated the result of transplantation in reversed orientation. No change was observed during 22 days after operation, except that a slight elevation was formed at the level of transplantation. Of course, there could not only take place no formation of extra pharynx as in the preceding case, but also the anterior branch of the host intestine kept away to the left from the grafted pharynx instead of connecting itself with it, as was revealed after the specimen was fixed and cleared.

Transplantation into the postpharyngeal region: When a pharyngeal piece, the same as in the preceding, was transplanted into the postpharyngeal region, a slight elevation was formed at that level, no further change, however, being observed either in the graft or in the host. But only in one case represented in fig. 68

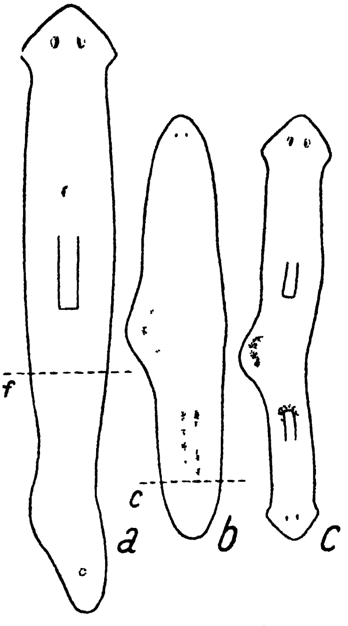
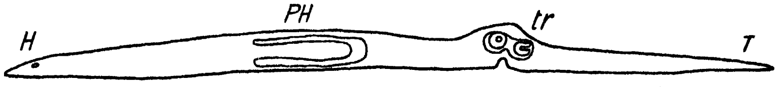


Fig. 63. Transplantation of a piece immediately anterior to the pharynx into the postpharyngeal region in reversed orientation and removal of the posterior part of the host: a, 60 days, fission took place at *f* level; b, 7 days later cut was made at c level and (c) head regenerated, 91 days from the beginning.



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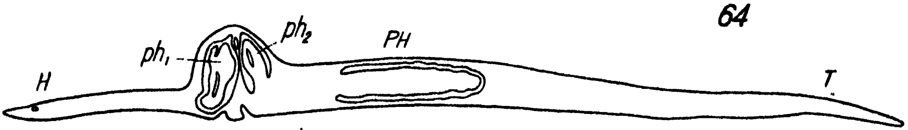

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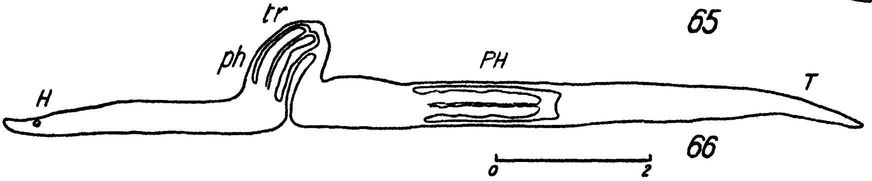

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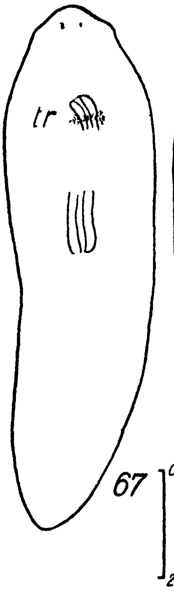
Fig. 64. Transplantation of the same piece as before into the postpharyngeal region, pharynx appeared in the graft (*tr*); Median longitudinal section of the fixed specimen, 23 days.
Fig. 65. Pharyngeal basis in the prepharyngeal region in normal orientation; extra pharynx (ph_2) developed in reversed direction besides the one (ph_1) regenerated in the graft.
Fig. 66. Piece from the midpharyngeal level in the prepharyngeal region in normal orientation; pharynx (*ph*) regenerated in the graft (*tr*); *H*, *PH*, *T* head, pharynx and tail of the host respectively.



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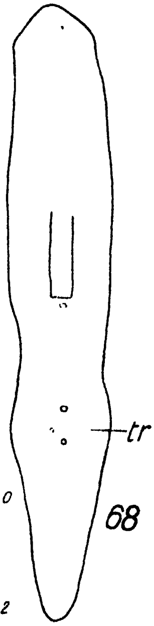

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Fig. 67. Transplantation of a pharyngeal basis into the prepharyngeal region in reversed orientation; only one pharynx formed in the graft in reversed direction, 22 days.
Fig. 68. Transplantation of a similar piece into the postpharyngeal region in reversed orientation; two mouths opened without formation of pharynx, 19 days, ventral view.

in which the piece was transplanted in reversed orientation, two mouth openings were found to have developed, one behind the other on the ventral surface of the graft.

10. Transplantation of the midpharyngeal piece

Small rectangular pieces were cut out from the middle part of the pharynx (cf. fig. 1 a, *ph.m*) and transplanted into the pre- or the postpharyngeal region of another worm. The original pharynx came to fall off in these cases.

Transplantation into the prepharyngeal region: In all 4 successful cases, a dorsal elevation was formed at the level of transplantation with the development of a pharynx in the graft. One of these cases is illustrated in fig. 66 in which the graft was brought in normal orientation into complete union with the host and the new pharynx also developed in the normal anteroposterior direction.

Transplantation into the postpharyngeal region: Two successful cases were obtained. In each case a slight dorsal elevation was formed. But, after all, no pharynx developed.

Now, we compare the results of experiments above described of three sorts of transplantation, i. e. those of pieces from just before the pharynx, from the pharyngeal base and from the middle part of the pharynx. When a piece just anterior to the pharynx is brought into the pre- or the postpharyngeal region, much tendency is still indicated in the graft towards induction of the pharynx. That the pharynx is induced to develop through the graft derived from the pharyngeal base may rather be regarded as a natural course of events, since in such pieces are included, from the outset, those tissues from which regeneration of the pharynx ought to occur. In one of the cases under consideration with the graft in the prepharyngeal region, besides the pharynx regenerated in the graft, another pharynx developed in the reversed direction (fig. 65). The development of this pharynx (ph_2) is considered to be due to the induction that took place in that part of the host prepharyngeal region which was situated posteriorly to the graft level (and which, viewed from the point of differentiation, must be regarded as more anterior at level than the graft tissue). But when a similar piece is brought to a level posterior to the pharynx, formation of a pharynx does not follow, except that a mouth opening is formed on the host ventral surface. More conspicuous are the differences when pieces from the middle part of the pharynx are brought to different levels. If such a piece is transplanted into the host prepharyngeal region, a pharynx always develops in the graft. But if it is transplanted into the postpharyngeal region, no pharynx and even no mouth opening result.

From the data above presented, it may be concluded that the piece just before the pharynx has a potency to give rise to a pharynx independently, regardless of the level of transplantation, that the piece from the pharyngeal base, if not under the influence of the host, can not proceed further in the induction of a pharynx than the formation of a mouth opening, and that the piece from the middle part of the pharynx is destined in the future to be wholly under the influence of the level of grafting.

D. Postpharyngeal Grafts

Grafts which were used in this series of experiments were small rectangular pieces cut out from the middle of the postpharyngeal region or somewhat more posteriorly (cf. fig. 1 a).

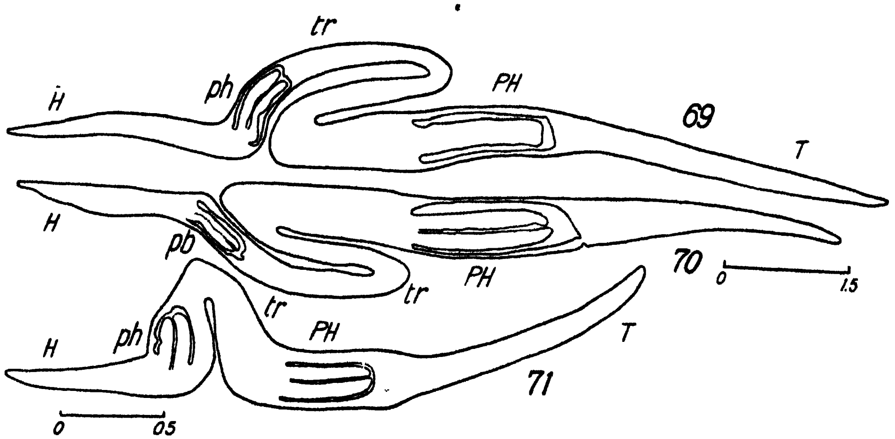
11. Transplantation of the postpharyngeal piece into the prepharyngeal region

Transplantations were successful in 17 cases in all, among which grafts were in normal orientation in 5 cases, at right angles to the host in one case, in reversed orientation in 10 cases, and united obliquely with the host in one case respectively. The results depend in these cases rather on the varying degrees of union between the graft and the host (cf. Table V).

Table V
Transplantation of Postpharyngeal Piece into Prepharyngeal Region.

Experiments			Results				
Mode of Union	Secondary Operation	Number	Regeneration of Head	Regeneration of Tail	Saccular Projection	Small Worm	Abnormal Forms
Complete Union in Normal Orientation	Not performed	2			2 (Pharynx developed)		
	Cut anteriorly	1	1				
Complete Union in Reversed Orientation	Not performed	1			1 (Pharynx developed)		
	Cut anteriorly	3		3			
	Cut posteriorly	2		2			
Incomplete Union in Normal Orientation		2				1	1
At Right Angles and Obliquely		2				2	
Incomplete Union in Reversed Orientation	Not performed	1					1
	Cut posteriorly	3	1				2

In general when these transplantation complexes are cut at a level anterior or posterior to the graft, a head regenerates from the anterior and a tail from the posterior cut surface in accordance with the polarity of the graft. In the cases where union is incomplete, both the head and the tail are regenerated from the graft itself and an independent worm body is formed,



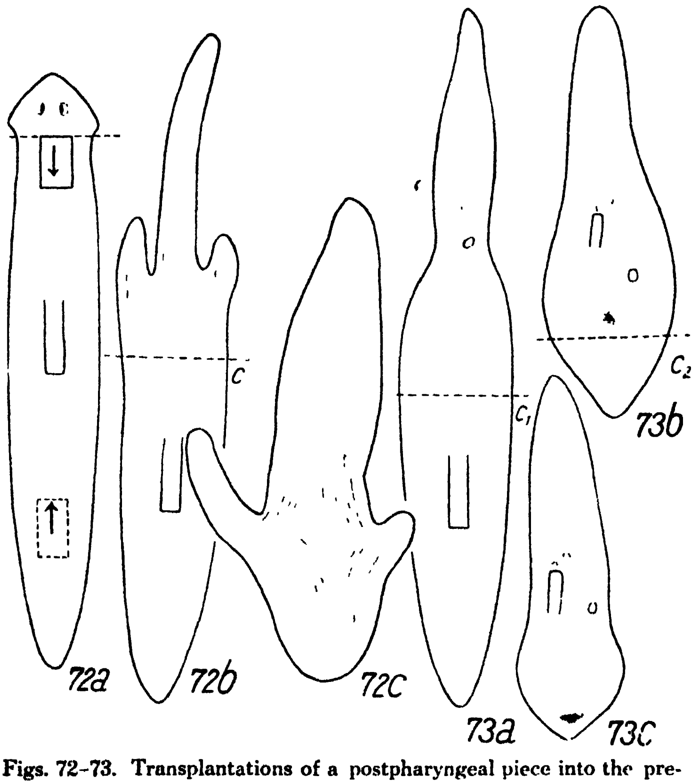
Figs. 69–71. Median longitudinal sections of the specimens obtained by the prepharyngeal transplantation of a postpharyngeal piece; fig. 69, in normal orientation, the graft projected on the dorsal side, 21 days. Fig. 70, similar specimen with the ventral projection, 21 days. Fig. 71, graft placed in reversed orientation, 90 days. *H*, *PH*, *T* head, pharynx and tail of the host, *ph* pharynx developed in the graft, *tr* graft.

though nourishment is taken from the host (cf. figs. 76, 77, 78). So far as the anterior side of the graft is in complete union with the host, a tail always regenerates from the posterior side that remains free, no exceptional case with head development being observed.

Cases in which union is complete: If a cut was not made after union, a prominent projection was formed at the level of transplantation either on the dorsal or the ventral surface, with a corresponding deep invagination on the ventral or the dorsal surface. Moreover, a pharynx always developed in the projection at the boundary between the graft and the anterior part of the host. In fig. 69 is represented a specimen with a dorsal projection, while in fig. 70 one with a ventral projection.

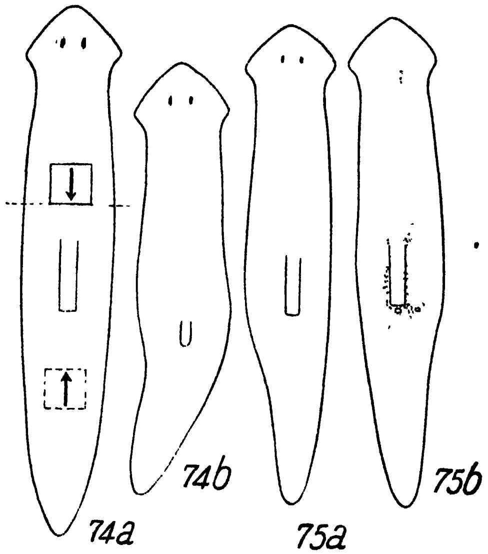
In the cases where the graft was placed in normal orientation, when a cut was made on the host body at a level just anterior to the graft and the anterior cut surface of the latter was exposed for the second time, a head developed therefrom and took command of the body posterior to it.

Fig. 71 represents a case with the graft transplanted in reversed orientation, the result being the same as in the case of fig. 69 with the graft in normal orientation. In the cases represented in figs. 72 and 73, the anterior part of the host was removed in the same transplantation as before. In either case the graft extended itself considerably forwards and a mouth was opened at the position indicated in the figure by a small circle of dotted line. Undoubtedly it was a



Figs. 72–73. Transplantations of a postpharyngeal piece into the prepharyngeal region in reversed orientation and removal of the anterior part of the host, fig. 72 a, showing the method of experiment; fig. 72 b, result after 16 days, posterior part of the host removed at c level; c, anterior piece at 38 days later. Fig. 73 a, another example of the same transplantation and operation as before at 24 days; when cut was made at c_1 level; b, anterior part, 21 days later the posterior part again removed at c_2 level; c, 57 days from the beginning.

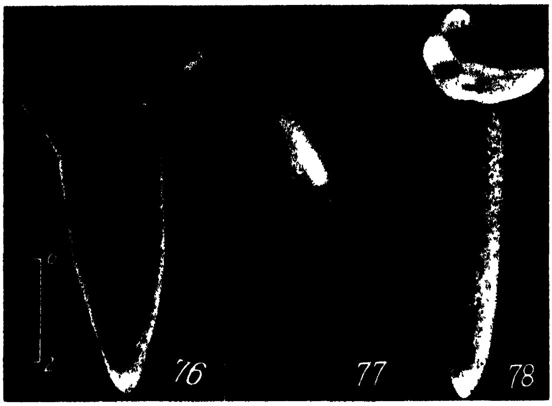
tail that was regenerated. In the case of fig. 72, small extensions directed forwards of the host tissue appeared on both sides of the graft, no head, however, being formed on either side. In the case shown in fig. 73, no such side projections were formed from the host. In these two cases, when the host body was cut at the level indicated by a transverse dotted line in fig. 72 b and 73 a, tail regeneration was inhibited at the posterior end of the anterior part of the host bearing the graft, and a small pharynx in reversed direction developed in the new tissue which had grown from the graft. In the case of fig. 73, besides the mouth situated towards the pharynx, another mouth opened on the median line (fig. 73 b). Later on, when this specimen was cut once more at the level shown by a dotted line in fig. 73 b, the posterior cut surface was again healed over and no regeneration occurred (fig. 73 c). Worms of such forms finally reached the state as shown in figs. 72 c and 73 c, and stood still without any movement so long as no stimulus was given. But, if pricked by the point of a hair-pencil, they moved in a direction opposite to the original polarity of the main body. The specimen represented in fig. 72 c, though possessed of a pharynx of unknown direction near its posterior end, showed no reaction towards food, whereas the one represented in fig. 73 c could draw near to and take it (hen's liver).



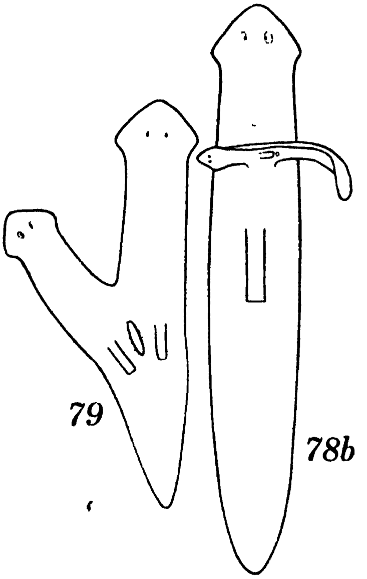
Figs. 74–75. In the same transplantations as before posterior part of the host removed, fig. 74 a, showing the method of experiment; b, result after 13 days. Fig. 75, another example of the same experiment at 42 days, a dorsal, b ventral view.

In similar experiments with the graft in reversed orientation, when the posterior part of the host behind the graft was removed, a tail regenerated on the cut surface (figs. 74 and 75). In the specimen of fig. 75 two mouths were formed.

Cases in which union is incomplete: Figs. 76, 77 and 78 represent cases, in every one of which as union was incomplete, a head and a tail regenerated respectively at the anterior and the posterior end of the graft, a pharynx, moreover, formed between the two, and thus an independent worm resulted. In the case of fig. 76, a lateral twin was formed owing to the lateral union. In the case of fig. 77, the individual which has grown from the graft was united with the host by its dorsal surface, and thus a dorsal twin was formed. In the case of fig. 78, the graft was brought into union with the host, the lateral surface of the former being united at right angles with the dorsal surface of the latter, and the composite body grew into a cross twin. The intestine of the graft was, in every case, in connection with that of the host and the food taken by the latter passed directly into the intestine of the former. But the body grown from the graft was also able to take food by itself.



Figs. 76–78 a. Three cases of incomplete union of the postpharyngeal graft with the host in the prepharyngeal region, each developing to a complete animal; fig. 76, lateral twin, 38 days; fig. 77, dorsal swin, 24 days; fig. 78 a, cross twin, 12 days.



Figs. 78b–79. Incomplete unions of the graft (continuation to preceding cases); fig. 78 b, the same specimen as before in outline, drawn from the living specimen. Fig. 79, specimen with two heads, one (right) regenerated from the host, other (left) developed from the graft, 55 days.

Since the posterior cut surface of the graft in the case of fig. 79 united almost completely with the host, no tail was formed by the graft itself. Meanwhile, a head and the following regions were formed from the anterior cut surface that remained free. A common tail, on the other hand, regenerated on removal of the posterior part of the host.

Now, in those cases in which both dorsal and ventral epithelia of the graft united merely with the dorsal epithelium of the host, the graft piece extended considerably outwards and developed into a queer shape provided unexceptionally with a long peduncle. In fig. 80 is given such an example. Forms which are similar to this were often met with also in those cases in which other regions were employed as grafts. But they were rarely provided with such a long peduncle.

12. Rotation of a small area with concurrent transplantation in the same position

A small rectangular area in the middle of the postpharyngeal region was rotated anteroposteriorly in 11 cases. In 4 cases among these the anterior part of the host was removed by a cut along the posterior margin of the graft, in 5 other cases the host tail region was cut off along the graft anterior margin, and in the remaining 2 cases, one complete and the other incomplete union, no cut was made. In one of the last mentioned where union was complete, no further change was observed than widening of the host body at the level of replantation. But in the other specimen, as the original anterior cut surface of the rotated area had not been brought into union with the host tissue, a head regenerated therefrom and two pharynges in opposite directions developed, one before and the other behind it. Furthermore, 3 experiments were made for the sake of comparison, besides those which were above described, with the graft transplanted in reversed orientation into the same position of another individual. In 2 cases among these, which were not accompanied with secondary amputation, no changes were observed. The experiments and their results are summarized in table VI.

Complete union: In 4 cases the anterior part of the main body was removed, the rotated area being left behind. In only one case among these a head developed at the new anterior end. In each of the 3 remaining cases a tail regenerated. In the case of fig. 81, fission occurred previous to the amputation, i. e. on the 15th day after operation, and a tail regenerated at the anterior as well as the posterior end of the part bearing the rotated piece. In this case the right anterior cut surface grew outwards to form a projection, at the base of which a pharynx (*ph*) was formed. But no head developed after all on the projection. A side projection appeared also in a homo-

Fig. 80. Sack-like projection as the result of transplantation of a postpharyngeal graft into the prepharyngeal region, both dorsal and ventral epithelia uniting with the host dorsal epithelium only, 33 days.

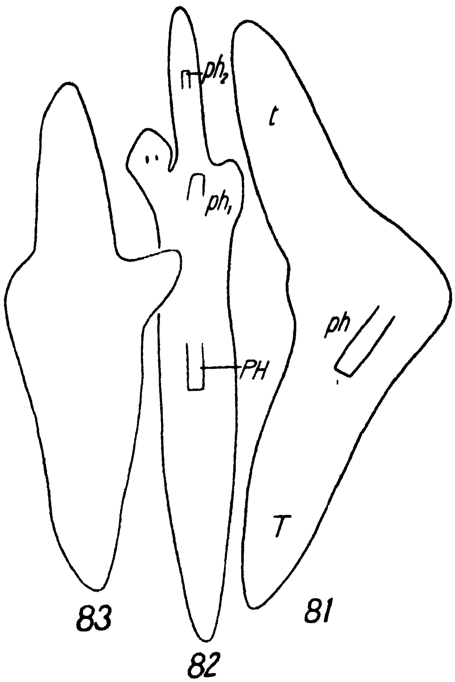
Table VI

Rotation of a Small Area in the Postpharyngeal Region.

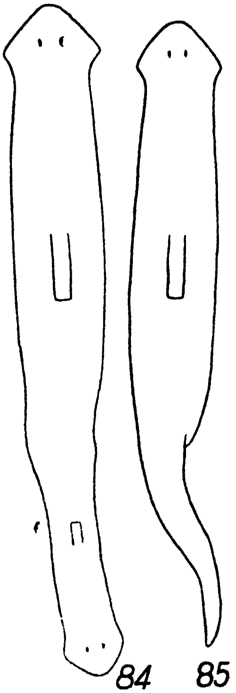
Experiments			Results		
Mode of Union	Secondary Operation	Number	Regeneration of Head	Regeneration of Tail	No Change
Complete	Not performed	1			1
	Cut anteriorly	4	1 (Polarity reversal occurred in the rotated body)	3	
	Cut posteriorly	5	2	3 (Polarity reversal occurred in the rotated body)	
Incomplete	Not performed	1	1 (Two pharynges appeared)		
Complete* Union	Not performed	2			2
	Cut anteriorly	1		1	

*Transplantation experiments for comparison.

plastic transplantation shown in fig. 83, but no pharynx was ever formed. In the case of fig. 82, a head regenerated from the left side of the main body near the base of the tail which had developed anteriorly from the rotated area. A normal pharynx (*PH*) was induced thereby in the main body. Besides, two more pharynges opposite in direction to the preceding developed, one (*ph*$_1$) at the level of union between the rotated area and the main body and the other (*ph*$_2$) in the new tissue of the anterior tail.



Figs. 81 82. Results of anteroposterior rotation of a small area in the postpharyngeal region and subsequent removal of the more anterior part; fig. 81, 25 days, before this period the posterior greater part was lost due to fission and regeneration occurred. Fig. 82, head regenerated from the host to the left side of the tail developed from the rotated area, in the latter appeared two pharynges in the same direction, 23 days. Fig. 83. As control to the preceding experiment, piece of another individual was transplanted to the corresponding level and the anterior part of the host removed, 49 days, ventral view.



Figs. 84–85. In the same experiments of anteroposterior rotation in the middle of the postpharyngeal region, the part posterior to the rotated area removed; in fig. 84 head produced, 38 days; in fig. 85 tail produced, 37 days.

Those heteropolar tails which were found in the preceding cases were formed, needless to say, through the growth of the grafts themselves.

Fig. 84 represents a case in which on removal of the tail region posterior to the rotated area, a head regenerated to the posterior side, i. e. on the anterior cut surface of the rotated piece. Fig. 85 shows a similar case in which, however, a tail developed. In such cases as the former, the second pharynx was always formed in that portion which had grown from the rotated piece.

Polarity reversal: Polarity reversal was observed in one case to have been induced in the neighbouring tissues of the main body through the rotation of the postpharyngeal area. It is indicated in figs. 86 and 87. A few days after amputation of the worm in front of the rotated area, fission occurred in the main body (fig. 86). A tail was formed at the anterior end of the anterior partner bearing the rotated piece, i.e. on the original posterior cut surface of the piece (b), as it was well expected, and at the same time a head regenerated on the posterior wound surface that had been produced through the fission of the worm. An eye on one side (fig. 86 c) appeared first and another on the other side followed, proving beyond doubt that it was a head that was regenerated posteriorly. Meanwhile, at the level of union of the two tissues of opposite polarity a pharynx developed with normal direction to the new head. On the other hand, from the tissue on both sides of the rotated area projections were formed, which grew in length as days passed (fig. 86 c), but began to be absorbed as the worm body increased in size (fig. 87 a). The posterior partner which had arisen from the fission above noted developed, as a matter of course, into a normal worm with a head developed at the anterior end (fig. 87 b).

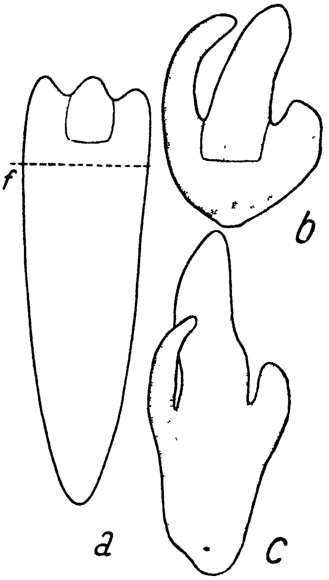


Fig. 86. Polarity reversal in the part posterior to the rotation in the postpharyngeal region; a, 5 days after removal of the anterior part, when fission took place; b, anterior part of fission, 12 days; c, 14 days, head with one eye regenerated to the posterior side.

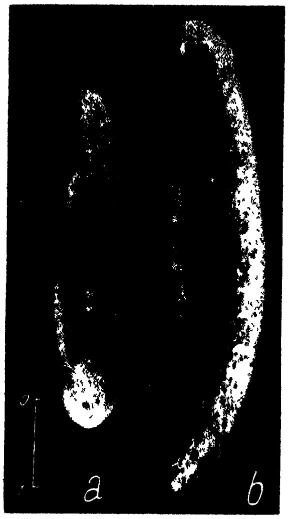
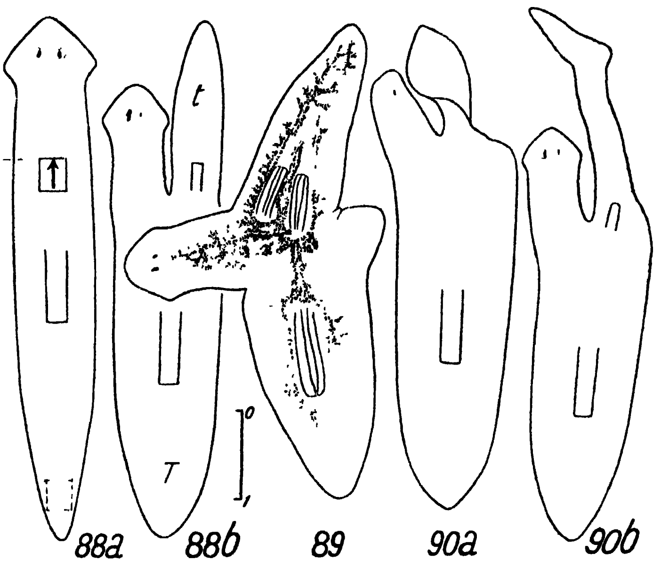


Fig. 87. Continuation of the preceding figure. Anterior (a) and posterior part (b) of fission in fig. 86 a at 24 days.

Incomplete union: In these cases of rotation of a small area, if the anterior cut surface was not brought into union with the main body, a head developed therefrom. Regardless of its shape, its influence on the latter was the same as in the transplantation of a head piece in that it induced two pharynges with opposite direction, one before and the other behind it.

As may be seen from the above examples of transplantation and rotation, a small piece which is taken from the postpharyngeal region shows, when grafted, a strong tendency to regenerate a head from its anterior and a tail from its posterior cut surface. But according to the level of transplantation or to the mode of union with the host, this property does not necessarily come to be manifested. In addition, it may be worth noticing that the graft taken from the postpharyngeal region is able to develop independently. In this respect the transplantation of a postpharyngeal piece is much different from that of a head or a prepharyngeal piece.



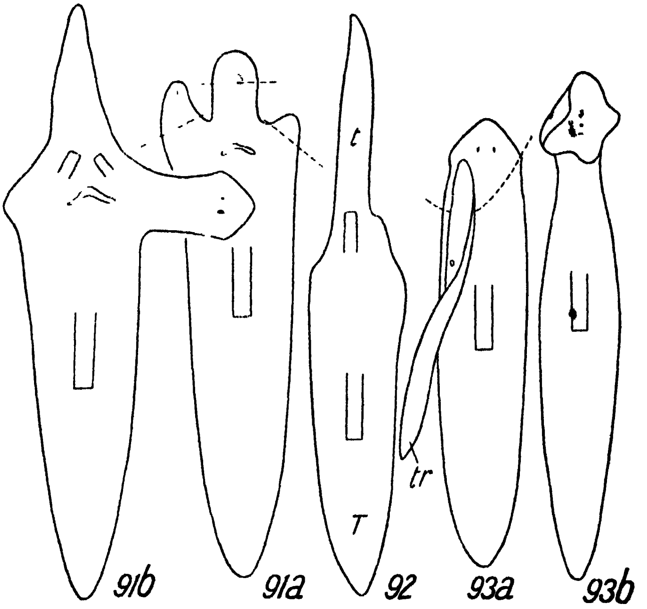
Figs. 88-90. Transplantations of a tail piece into the prepharyngeal region in normal orientation and removal of the anterior part of the host, fig. 88 a, showing the method of operation, b, result at 22nd day; tail developed from the graft and head regenerated from the host on the left side, pharynx appeared in the new tail in reversed direction. Fig. 89, in a similar example two pharynges developed at the base of the anterior tail in reversed direction, 71 days. In fig. 90 the graft dorsoventrally reversed. a, 10 days, and b, 23 days.

E. Tail Grafts

13. Transplantation of the tail piece into the prepharyngeal region

As the tail grafts were used pieces which were of a rectangular form as usual and were cut out as near as possible from the posterior end of the worm (cf. fig. 1 a, *t*). Transplantation of the pieces into the host prepharyngeal region was successful in 6 cases, being placed in normal orientation in all these cases except one.

Cases in which union is complete: In the cases where a tail piece is transplanted in normal orientation with subsequent removal of the host head, a tail develops from the cut surface, i. e. at the original anterior end of the piece, as may be seen in figs. 88, 89 etc. In the case of fig. 88, a head was regenerated from the left anterior angle of the host and a pharynx with reversed direction developed at the base of the tail which had already grown to a full extent from the graft (fig. 88 b). In the case of fig. 89 also, a head regenerated from the host much the same as in the preceding. But through the existence of the tail which had developed from the graft and attained a considerable size, the head was turned towards the direction at right angles to the main axis of the body. Although a projection had also been formed to the right from the anterior cut surface of the host, it could not develop into a head. In this specimen, furthermore, two parallel pharynges developed in the opposite direction. (The one on the right preceded the other, which did not appear until the regenerated head grew larger).



Figs. 91–93. Incomplete unions of a tail piece; fig. 91, anterior part of the host romoved after the piece united, anterior and posterior sides being free, with the host prepharyngeal region in normal orientation, 10 days when the anterior elongated part of the graft and two lateral processes of the host cut removed; b, 38 days, tail formed on the graft with two pharynges in reversed orientation and head regenerated from the right stump of the host. Fig. 92, graft dropped off next day when anterior part of the host removed, and yet a perfect tail developed to the anterior side, 52 days. Fig. 93, the graft dorsoventrally reversed; a, 16 days, exceedingly elongated graft turned backwards on the host dorsal side; b, graft cut isolated with the host head, 142 days.

Fig. 90 represents a case with the graft in reversed dorsoventral orientation, in which also a head was regenerated from the cut surface on the left side of the host. The graft extended itself in an irregular form and gradually turned itself over, until normal dorsoventral orientation was reached (fig. 90 b).

In the two following cases, the graft was too small for the anterior and the posterior cut surfaces to be united with the host, so that only the lateral cut surfaces were united. In the case of fig. 91, after the anterior part of the host was cut off, regeneration took place in the graft, which soon resulted, however, in the healing over of the anterior end. Regeneration occurred also on the cut surfaces on both lateral sides of the host and after about 10 days an eye was formed on the left regenerate (fig. 91 a). The anterior end of the graft and the regenerates on both sides were then cut off as indicated in the figure by broken lines. After 4 days a distinct tail developed on the anterior cut surface of the graft, and at the same time two pharynges with reversed orientation made their appearance (fig. 91 b). Thereafter a head developed from the cut surface on the right of the host. As it grew larger, it turned in a direction at right angles to the entire complex. In the case of fig. 92, the graft fell off from the host on removal of the host anterior part. But a part of the new tissue which had already formed by that time grew into a tail, in which a pharynx with reversed direction was formed.

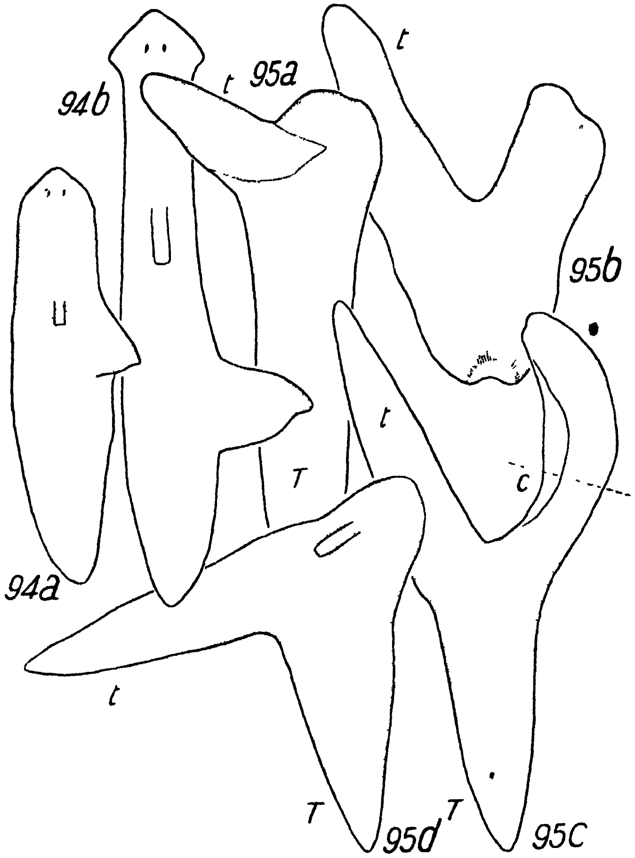
Cases in which union is incomplete: In another case with incomplete union (fig. 93), only the anterior cut surface of the graft was united with the dorsal surface of the host. As the graft developed it fell backwards giving rise to a tail with reversed dorsoventral orientation. When the head region of the host was removed, a new head was regenerated (fig. 93 a). Then (on the 16th day after the first operation) the host head in connection with the graft was separated from the rest of the body at a level indicated by a broken line. A worm resulted with the head of the host at the anterior end (fig. 93 b).

As demonstrated in the preceding experiments, a tail piece when brought into the other places always develops into a tail regardless of its orientation at the time of transplantation, i. e. regardless of its original polarity. And a pharynx is formed in the graft, more precisely in the new tissue which has grown from the graft. If a head is regenerated from the host in the neighbourhood of the graft, development of the eye on that side which is near to the graft is retarded by the invasion of tissue from the graft (cf. figs. 88, 90 etc.). That development of the pharynx is not necessarily due to induction by a head which is regenerated is indicated by such a case as shown in fig. 92.

14 (F). Rotation of a small area in the front of the posterior part immediately after fission

A small rectangular area was chosen in a comparatively anterior part of the posterior partner which had resulted from fission, and it was rotated anteroposteriorly. After reunion a cut was made at a level anterior to the rotated area. In the first case (fig. 94), after removal of the region anterior to the rotated area, a head regenerated. Several days passed before the second removal of the anterior part was executed, which was followed again by regeneration of a head. Meanwhile. from the anterior end on the right of the rotated area a slight dorsal swelling appeared, which gradually extended backwards (fig. 94 a). Through prolonged observations during which this projection was taken as a landmark, it was revealed that the rotated tissue between the head end and the posterior end of the projection was considerably elongated (fig. 94 b).

In the second case, operation was postponed until a little time had elapsed after fission and regeneration of a head took place at the anterior end, two eyes making their appearance. Here, on removal of the anterior part of the worm, a tail regenerated from the cut surface of the rotated area and extended forwards and to the left, while the anterior cut surface of the host which had been healed over extended forwards and to the right of the composite (fig. 95 a). Meanwhile, the posterior part of the worm was lost through fission and a new tail was regenerated (fig. 95 c). Then, the projection on the right side was again cut at a level indicated by a broken line in fig. 95 c, but here also no head was regenerated. Instead, a pharynx was formed in the rotated area (fig. 95 d).



Figs. 94–95. Anteroposterior rotations of a small part in the front of the posterior part of fission (originally postpharyngeal region); fig. 94 a, 12 days after removal of the part anterior to the rotated area, head formed; b, 25 days. Fig. 95 a; 7 days after anterior removal in another specimen, fission took place; b, anterior part of fission, 14 days; c, 20 days, second removal of the anterior part grown from the host tissue was executed at c level; d, 40 days from the beginning, head formation inhibited to the end but pharynx appeared in normal direction.

In the third case also, the worm was operated upon almost at the same stage as in the preceding case (fig. 96). In this case both the dorsal and the ventral epithelia of the rotated area were united with the dorsal epithelium of the main part. Moreover, the graft stood at right angles to the host, the ventral surface of the former having been directed forwards and the dorsal backwards. When union occurred in such a manner, the anterior part of the composite was removed. From the posterior end of the rotated area that remained free (*fr.e*) a tail developed and extended itself at right angles to the main body, while the ventral epithelium at the anterior end of the former extended itself forwards, dividing, as it were, the dorsal epithelium of the latter into two lateral halves (fig. 96 a_1). Two eyes appeared on each side of the host dorsal epithelium. On the 21st day from the first operation, the old tail was cut off at the level indicated by a broken line in fig. 96 b. As the worm was possessed, on its dorsal side also, of the ventral epithelium developed from the graft, it soon turned itself over and could glide over the bottom of a vessel with the ventral side of the graft (fig. 96 c_1). Then, regeneration was checked at the cut end of the old tail that was apart from the bottom of the vessel, but a black spot appeared in this portion. Whether it was an eye or not could not be ascertained. Further, only a single pharynx developed in the worm, and corresponding to it a mouth opened not only on the ventral side of the host, but also on the dorsal side which was lined with the ventral epithelium derived from the graft.

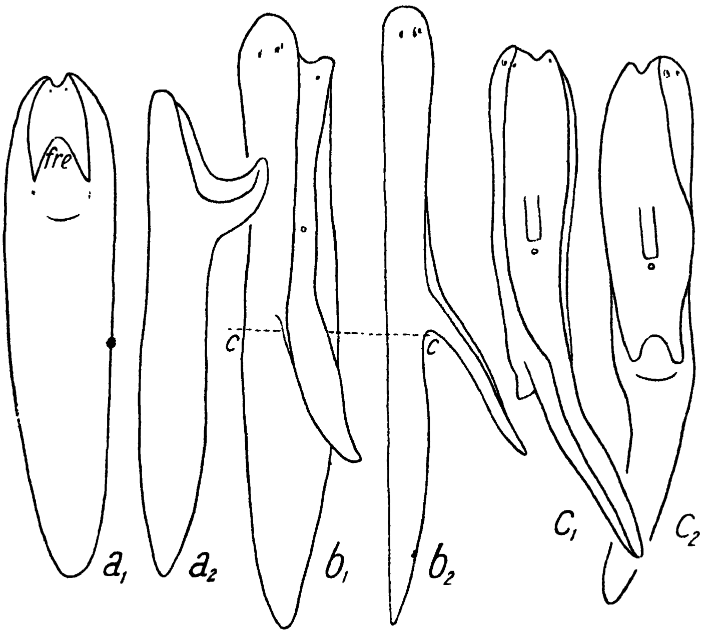


Fig. 96. Incomplete union of the rotated piece, free end (*fr.e*) being posterior, with the main part of the body; a_1, 7 days after the anterior removal, dorsal, a_2, lateral view; b_1, 20 days, dorsal, b_2, lateral view, posterior part of the host removed at c level; c_1, 24 days, dorsal, c_2, ventral view, tail regeneration inhibited.

Although in the above experiments rotation of the small area was made in an anterior region of the posterior fission-body, the results were approximately the same as in those experiments executed in the postpharyngeal region of the normal worms. This fact may probably be explained by the supposition that the anterior region of the posterior fission-body at a time immediately after separation is not yet fully differentiated and preserves still much of the original properties of the postpharyngeal region.

15 (G). Double transplantation to the anterior and posterior sides

The following mode of transplantation was successful in only one among many trials. A small piece taken from the postpharyngeal region of a worm was transplanted into the prepharyngeal region of another worm, and at the same time a head piece of the former into the postpharyngeal region of the latter.

Here, the postpharyngeal piece was made to be united with the host in normal dorsoventral and reversed anteroposterior orientation, while the head piece in reversed dorsoventral and normal anteroposterior orientation. When, thereafter, the head and tail regions of the host were cut off before and behind the grafts, a tail developed at the anterior and a head at the posterior end in the same way as in the foregoing experiments with a single graft (fig. 97 a_1, a_2). Further, when after 61 days the graft head was removed, a head was regenerated, and a pharynx (ph_1) with reversed direction was induced immediately behind the old pharynx (*PH*) of the host (fig. 96 b). Moreover, in the tail developed from the graft also, a pharynx (ph_2) with reversed direction was similarly formed. The worm took food and enlarged. When stimulated, it moved towards the direction of the head, though the polarity of that part derived from the host remained evidently unchanged. On the 128th day after the first operation the worm was divided into three at the levels indicated by broken lines in fig. 97 b, thus isolating again the host part in the middle from other parts. The results were as follows. As to the anterior part of the worm provided with the tail, a head was produced from the cut surface, and as to the posterior part including the head, a tail was formed from the cut surface; these parts developed each into a perfect individual (fig. 97 c_1, c_3). Meanwhile, as regards the middle part which represented the original tissue of the host, the anterior cut surface was healed over and from the posterior cut surface alone a tail was regenerated (fig. 97 c_2). The anterior cut surface which had been healed over was again cut, but no regeneration took place as before. Yet, this imperfect regenerate, when stimulated, moved slowly forwards, proving that the original polarity was still preserved. This body under consideration did not take food and accordingly became weaker and smaller, exhibiting no further change during 43 days after it was isolated.

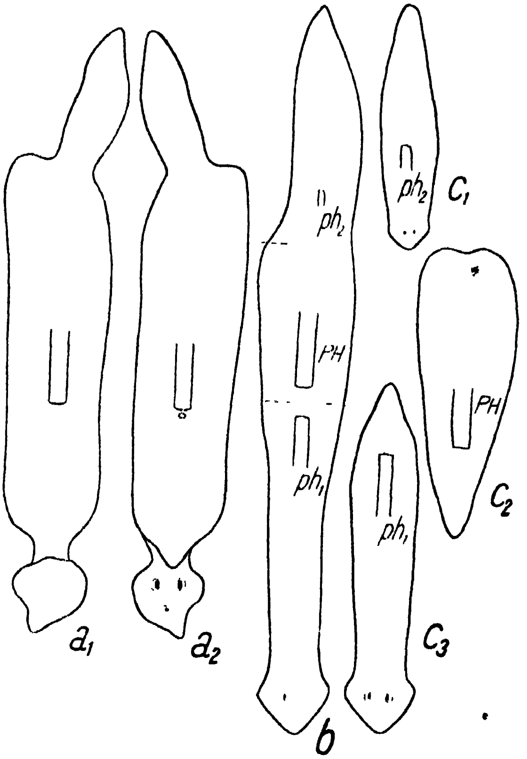


Fig. 97. Double transplantation of a postpharyngeal piece to the anterior side of the prepharyngeal region in reversed orientation and a head piece to the posterior side of the postpharyngeal region in normal but dorsoventrally reversed orientation; a_1, 13 days after anterior and posterior parts of the host removed, dorsal, a_2, ventral view, b, again the grafted head removed, 100 days in dorsal view. On 128th day the specimen was cut into three parts; c_1, the anterior part originated from the postpharyngeal graft, c_2, the host, c_3, the posterior part with the head graft on the posterior side, 143 days.

II. Union of Large Pieces

In the above category of experiments in which a small piece from one region of the planarians is transplanted into other regions of the body, so far as the graft is united completely with the host, new tissue always arises between two components, the quantity of which increases in proportion with the topographical difference preexisting, i.e. the distance originally presented between the graft and the host. It is also known from the results of experiments that considerable differences in behavior are manifested between a graft from the head region and one from more posterior regions, especially from the postpharyngeal region. In the case of the former the graft, instead of growing by itself, induces the growth of the host tissue, while in the case of the latter the graft grows by itself. And if it is the postpharyngeal region that is induced to grow, a pharynx develops in the new tissue. On the other hand, when a head or a prepharyngeal piece is transplanted into the postpharyngeal region, it directly reorganizes the tissue of that part and induces the formation of a pharynx.

Then, in the next place two large pieces cut out from different levels of the worm are united in various orientations, and in the light of these experiments the results of the preceding experiments with small pieces are criticized, especially for the formation of new tissue on the plane of union and the mutual influence of the pieces united.

16. Union of pre- and postpharyngeal regions in normal orientation

The body of a planarian being separated into three by the cuts before and behind the pharynx, the anterior and posterior parts were next brought to be united by their cut surfaces. Between two components new tissue appeared in a large quantity, and a pharynx developed in it. In fig. 98 a are represented the parts to be united (*ap* and *pp*), in b the mode of union and in c the final result. This experiment of median substruction was already conducted also by Li (1928) with the same results as the above, except that he did not report whether a pharynx developed or not.

17. Union of pre- and postpharyngeal regions in reversed orientation

A prepharyngeal piece from which the head had been removed was united in reversed orientation with the postpharyngeal piece, i.e. the anterior cut surface of the former was brought into connection with the same of the latter as indicated in fig. 99 b. As the result new tissue was also formed along the line of union, and in the new tissue or at its boundary with the old tissue of the postpharyngeal piece a pharynx was produced. Further, a tail was regenerated at the original posterior end of the prepharyngeal piece, and here a pharynx was formed in the same way as in the ordinary cases. Five cases which were accompanied with such results were obtained. In the case of fig. 99 c, two parallel pharynges were formed in the new tissue. In the case represented in fig. 100, projections without any differentiation appeared on both sides of the position where union of two pieces took place. On the 22nd day after union, a cut was made in this specimen in such a way that a part of the prepharyngeal piece remained in connection with the postpharyngeal piece. From the anterior cut surface of this complex, in accordance with the intrinsic polarity of the smaller component, a tail was regenerated. On the other hand, a head developed as might be expected from the posterior cut surface of that part which had been cut off. This part, then, developed into a perfect worm. In the case of fig. 101, a small projection was formed after union at the left anterior end of the prepharyngeal piece. It functioned as a head for both components, though no eyes after all were formed in it. The three specimens, which were above described, though provided with well-developed pharynges were never observed to react upon, much less to take the food that was given. It is assumed that although presence of a head is not necessitated for an animal to take food, it is needed at least that it should as a whole be possessed of

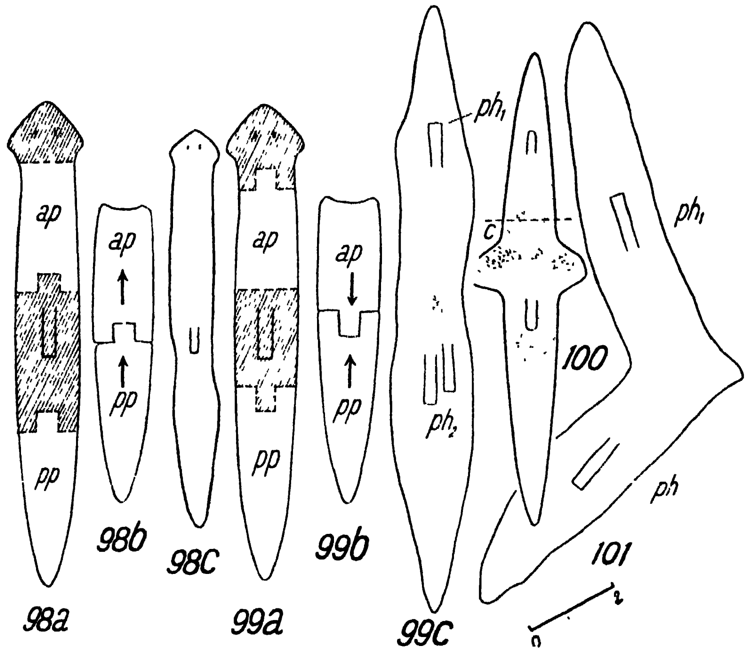


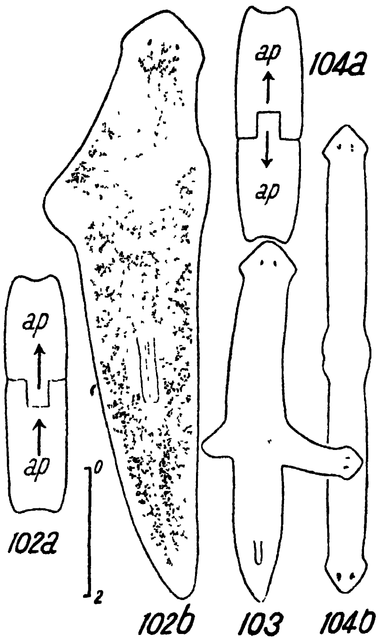
Fig. 98. Combination of pre- and postpharyngeal parts in normal orientation, a, showing size, form and position of two components, b, mode of union, c, result of 9 days. *ap* prepharyngeal piece, *pp* postpharyngeal piece.

Figs. 99-101. Combinations of pre- and postpharyngeal parts in reversed orientation, fig. 99 a, showing size, form and position of two components, b, mode of union, c, result of 30 days. Fig. 100, prepharyngeal component with concave surface and postpharyngeal component with convex surface, 22 days. Fig. 101, another example of the reversed union of a prepharyngeal part with a postpharyngeal part, 36 days.

some sort of orientation. Since no definite orientation was found in such tail bipolar forms as the above, it may be considered that all the physiological functions including food-taking could not be here in normal order.

18. Union of two prepharyngeal pieces in normal orientation

When two prepharyngeal pieces, both in normal orientation, were united one behind the other as indicated in fig. 102 a, a head and a tail were regenerated respectively at the anterior end of the anterior piece and at the posterior end of the posterior piece, and a pharynx, moreover, was produced within the posterior piece, a complete worm thus resulting (fig. 102 b). A small amount of new tissue then formed along the line of union between two components. In the case of fig. 103 in which union was incomplete, a head developed at the right anterior end of the posterior piece. It came afterwards to be directed at right angles to the main axis of the union complex.



Figs. 102–103. Combinations of two prepharyngeal parts in isopolar direction, fig. 102 a, showing mode of union, b, result after 25 days, drawn from the mounted specimen. Fig. 103, lateral head produced at the united level, 14 days.

Fig. 104. Combination of two prepharyngeal parts in heteropolar direction, a, showing the mode of union, b, result after 26 days.

19. Union of two prepharyngeal pieces in reversed orientation

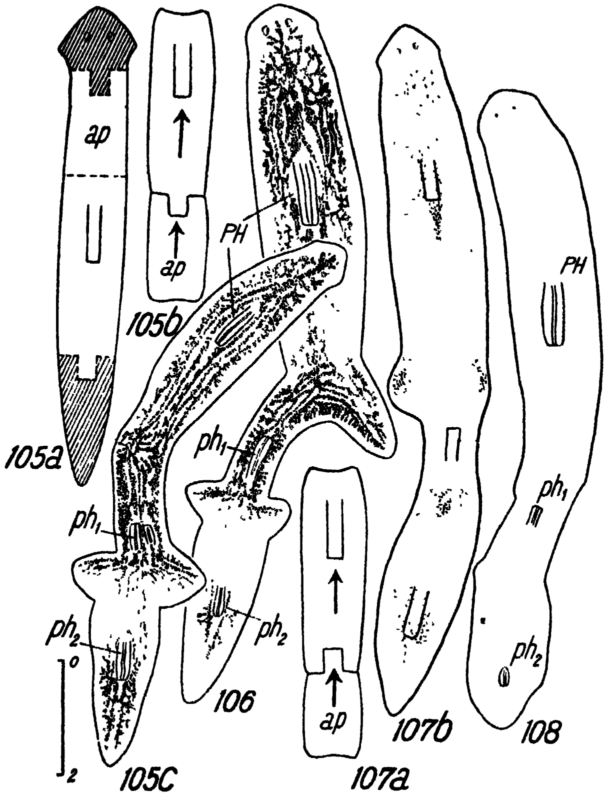
As indicated in fig. 104 a, two prepharyngeal pieces which were similar as those employed in the previous experiments were united by their posterior cut surfaces, one of the grafts being in reversed anteroposterior orientation. A head was regenerated at each end that remained free. While both components in this case elongated themselves decreasing at the same time in width, no tissue was newly formed on the plane of union and no pharynx developed (fig. 104 b).

20. Union of two postpharyngeal pieces by their anterior cut surfaces

When two tail pieces which were taken from approximately the same levels were united in reversed orientation by their anterior cut surfaces, new tissue was not formed at all along the line of union (Okada and Sugino, 1934, II, fig. 2). In some specimens, though a mouth opened ventrally on the median line at the level of union, no pharynx developed after all. This experiment was already conducted by Goetsch (1921) and Li (1928), their results being identically the same as ours.

21. Interchange of positions between pre- and postpharyngeal regions

If a prepharyngeal piece of which the head had been removed be united in normal orientation with the posterior end of the postpharyngeal piece of which the tail had been removed, new tissue arose on the plane of union (figs. 105 c–108). The polarity established in the new tissue, however, was reversed to the original polarity of each of the two components. Accordingly, a pharynx in reversed direction (ph_1) was formed in this tissue. Further, another pharynx with normal orientation developed in the prepharyngeal piece (ph_2). Thus in all, three pharynges were obtained. Fig. 105 c and Fig. 106 show specimens, each of which was derived from the union between a prepharyngeal and a postpharyngeal piece, the anterior cut surface of the former having been cut in a shape of ⊔, while the corresponding posterior cut surface of the latter in a shape of 凸 (fig. 105). Fig. 107 b and fig. 108 are the results obtained from the experiments, in which the grafts to be united were provided with such cut surfaces that were opposite in shape to those in the preceding experiments (fig. 107 a).



Figs. 105–108. Displacements of pre- and postpharyngeal regions in normal direction, fig. 105 a, showing size, form and position of parts used for the experiment, b, mode of union, c, result after 13 days, drawn from the mounted specimen; fig. 106, another specimen of the same experiment, 19 days. Fig. 107, prepharyngeal component with convex anterior surface and postpharyngeal component with concave posterior surface, a, showing the mode of union, b, result after 16 days; fig. 108, another example of the same mode of combination, 12 days. Notice the appearance of an extra pharynx or pharynges between two components in reversed direction; *PH* old pharynx in the pharyngo-postpharyngeal component; ph_1 pharynx produced in the new tissue; ph_2 that regenerated in the prepharyngeal comopnent.

The results of the above experiments on the union of large pieces may be summarized as follows. If union occurs between the prepharyngeal and the postpharyngeal pieces, no matter in what way they may be united, new tissue always appears between two components, and regardless of the union being normal or reversed, pharynges that may be formed are always directed from the prepharyngeal towards the postpharyngeal region. Thus, the union between a piece anterior to and a piece posterior to the pharynx is a preliminary indispensable for the development of a pharynx, whereas the presence or the regeneration of a head does not by itself constitute a necessary condition. On the contrary, when two prepharyngeal or postpharyngeal pieces which have been taken from approximately the same levels are united by their cut surfaces, new tissue is never formed. In these cases, even if a head is formed at each end of the complex, no formation of pharynx, needless to say, is ever observed.

III. Union of Lateral Halves

As was already stated in the introduction, it is the aim of this series of experiments to investigate the mutual influence of the components which appear in a complex, when different regions of planarians that have been longitudinally cut are united uninterruptedly by their lateral cut surfaces from the head to the tail end. The methods of experiments are as follows. Two worms of approximately the same length are chosen, first deprived of the head as shown in fig. 109 a, and then longitudinally cut into halves. A lateral half, right or left, of a worm is interchanged in normal orientation with that of the other (fig. 190 b). Or a half of a worm is brought into union in reversed orientation with the half of the same side of another worm (fig. 109 c).

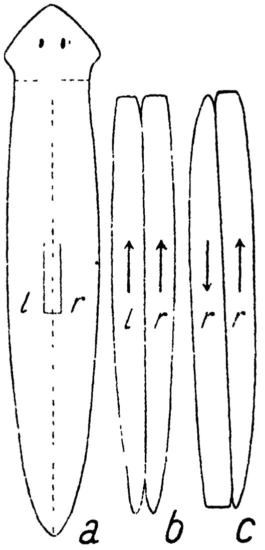
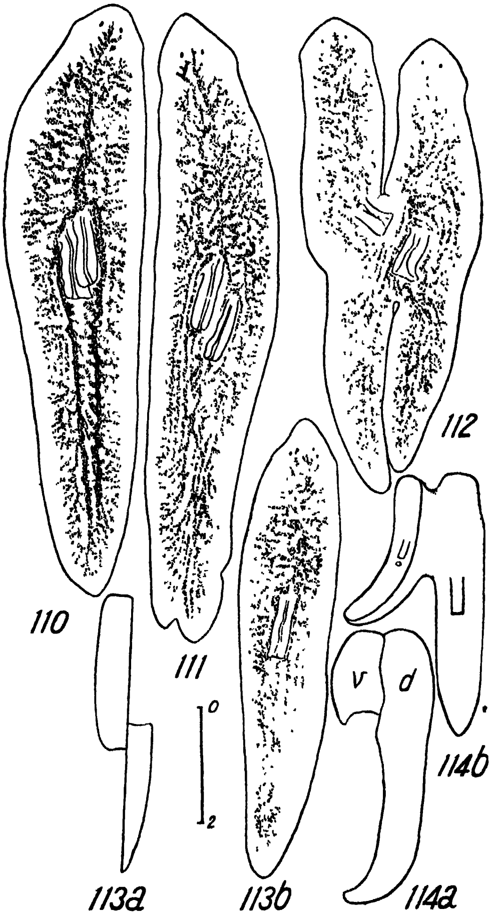


Fig. 109. Diagrammatic representations of homo- and heteropleural reindividualization, a, showing division of worm into halves, b, mode of heteropleural and c homopleural combination.

22. Interchange of a lateral half between two individuals

Those which constitute the first series of experiments were heteropleural union of the right half and the left half of the worms longitudinally divided. In 4 among 5 successful cases one half was united with the other in normal dorsoventral orientation, and in the remaining case in reversed dorsoventral orientation. In addition, one more case will also be described in which the left half of the prepharyngeal region of a worm was united with the right half of the postpharyngeal region of the same worm.

When the lateral halves to be grafted were placed in normal dorsoventral orientation and brought next into complete union, a normal head was regenerated, some unevenness of the anterior surface of the complex at the time of union being negligible; new tissue was not formed between the halves except some colourless trace of union along the median longitudinal line of the compound body. In figs. 110 and 111 are given sketches of the internal structure from mounted specimens which were fixed (the complex of fig. 110 after 23 days, that of fig. 111 after 26 days) and cleared, and in each of these cases two pharynges were regenerated; the original pharynges had been removed at the time of operation. It may further be seen how the intestine once disorganized by the cut becomes gradually repaired and reconstructed. That two pharynges were formed is considered to be due to the fact that two halves were united by somewhat different levels instead of exactly by the same. For in another example in which the union seemed to be more complete (Okada and Sugino, 1934, II, fig. 5), only one pharynx was formed provided none the less with two mouth openings.



Figs. 110–114. Heteropleural combinations; fig. 110, result of 23 days; fig. 111, of 26 days; fig. 112, incomplete reindividualization in 26 days; fig. 113, oblique union of an anterior half (prepharyngeal region) of the left side with a posterior half (postpharyngeal region) of the right side, a, showing the mode of union, b, result after 26 days. All drawn from mounted specimens. Fig. 114, combination of two right halves, one in normal and other in dorsoventrally reversed orientation, a, state after 3 days, when posterior greater part of the left partner dropped off, b, 71 days, two worms without head united back with back.

In fig. 112 is shown a case of incomplete union of two halves, for each of which a head and a tail regenerated with the subsequent formation of a pharynx.

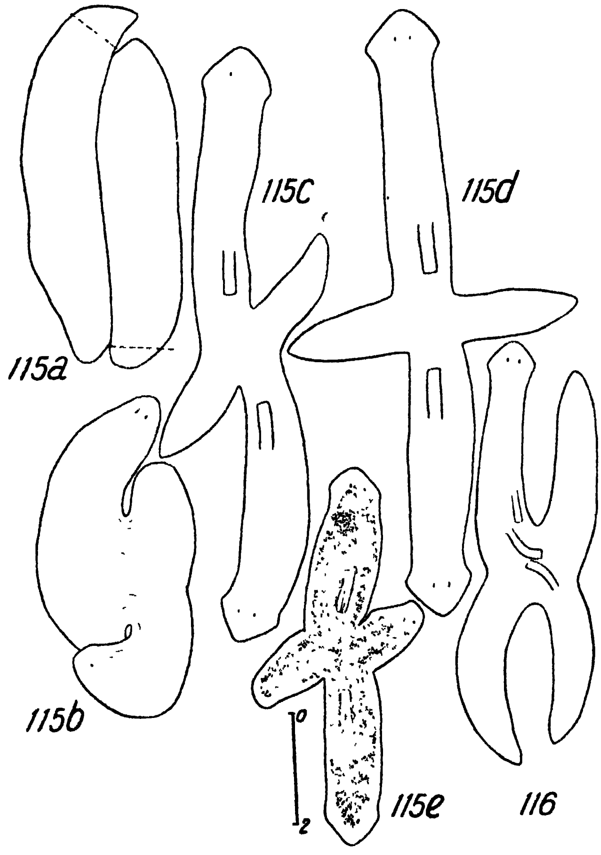
Fig. 113 represents a case in which the left half of the prepharyngeal region was brought into union with the right half of the postpharyngeal region (fig. 113 a). Each of them regenerated its fellow-half which was lacking on the other side. A head was completed at the anterior and a tail at the posterior end of the complex, and a pharynx was formed in the new tissue at the level of union (fig. 113 b).

In the only one example of dorsoventral reversed union, the posterior end of one component had fallen off (fig. 114 a). While two anterior ends of this specimen had been healed over separately, no head was regenerated from either of them. Consequently no eyes developed. As days passed, each of the components got to separate own dorsal epithelium from that of the other, and the final result was reached in which two headless individuals were combined back with back (fig. 114 b).

23. Homopleural combination

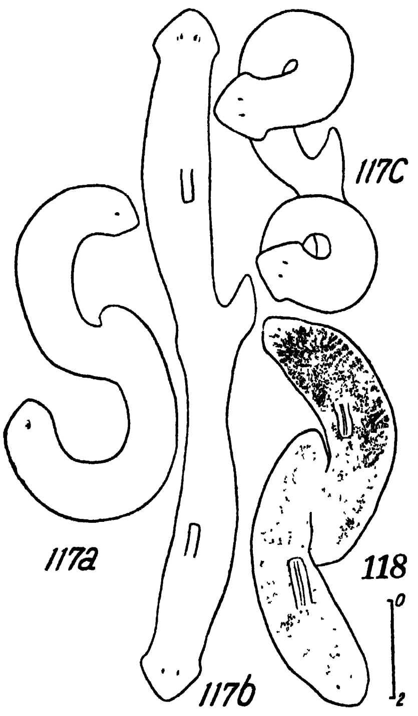
In all 10 cases of experiments, with the exception of 2 in which one component was displaced in relation to the other so that they were united only by the posterior ends, each component regenerated a head and a tail and gradually diverged from the tail and the head of the other component, the final result being a cross-shaped twin.

Fig. 115 a indicates the state of things when 6 days had elapsed after two left halves were united with each other. The projection which appeared from the anterior end of each component was cut at the level indicated by a broken line in the figure. This complex continued clockwise rotatory movements, the middle point of the body as the centre, on a fixed spot in the vessel. Meanwhile, about 16 days after the first operation, two eyes appeared at the one, and another at the other end of the complex, as indicated in fig.



Figs. 115–116. Homopleural combinations; fig. 115 a, 6 days, anterior end of each component removed; b, 10 days; c, 33 days; d, 43 days later; e, the same specimen in the fixed state, showing the intestinal branching. In fig. 116 head regeneration inhibited in one component and 3 pharynges appeared in the fused part, 29 days.

115 b. New tissue was formed between the head of one component and the tail of the other; between these an incision arose and deepened, so that those parts which had been united together became gradually separated; finally, an independent worm, so to speak, developed on each side. An independent pharynx was formed, of course, in each component. The state of the complex on the 39th day after operation is figured in fig. 115 c. According as the tail of each component was brought into completion the complex took a cross-shape as outlined in fig. 115 d. In fig. 115 e in which a sketch of the internal structure is given from the specimen fixed 10 days after the state in fig. 115 c, it can well be seen how a posterior intestinal branch of one component enters into the tail region of the other. In all the other cases the results were the same as in this.



Figs. 117–118. Incomplete unions of two halves in homopleural combination; fig. 117, combination of left halves, a, 15 days; b, 38 days; c, the same in the contracted state. Fig. 118, combination of right halves, 31 days, showing the intestinal branching.

But two pharynges were sometimes formed in one component. Moreover, in one of such cases head regeneration was inhibited in one component (fig. 116). In this specimen, furthermore, each of the two pharynges which developed in the reversed direction at the level of union was directed not towards the tail which belonged to the same component as it did, but towards that which belonged to the other. This fact seems to indicate that the pharynx is formed in such cases in cooperation with the post-pharyngeal region of the strange component which occurs to lie near by rather than with that of the proper component which lies far apart.

Figs. 117 and 118 are examples in which two components were, at the time of operation, so much displaced on the surface of contact that they were united with each other only by a small portion at the posterior end. The state of things on the 15th day after operation is given in fig. 117 a, in which an eye is seen to have been developed at each end. In fig. 117 c is represented the complex on the 38th day after operation and when it was contracted, and in fig. 117 b the the same when it was relaxed. In fig. 118 is shown a complex developed from the homopleural combination of right halves, the figure being drawn from the mounted specimen fixed on the 31st day after operation. In such cases a pharynx was formed independently in each half, and the intestine which belonged to one half did not enter into the other half.

To sum up the results above described, when two lateral halves of planarians are combined at the corresponding levels, new tissue is not formed between them. Hence, when different regions of heteropleural pieces derived from two worms are intimately united at their corresponding levels, all the regions and the organs of the complex are of single formation. On the contrary, when one component is combined with the other in reversed orientation, different regions come to be united at different levels, and new tissue arises along the whole line of union, that derived from one component behaving as if it drives away that from the other so as to supplement the lost half by itself. Hence, here results always a twin which is partly united.

SUMMARY OF THE EXPERIMENTS AND CONSIDERATION OF THE RESULTS

I. Fate and influence of the graft on the host: Considering the data of experiments of the first category, we are led to conclude that the fate of a grafted piece is determined in the first place by its origin, in the second place by the level of transplantation, and in the third place by the mode of union with the host (i. e. the degree of union and the orientation).

1. *Head grafts:* The head piece, no matter in what region and in what orientation it may be grafted, always develops into a head. Its influence on the host is great.

According to SANTOS (1929, '31 p. 152), the development of the head graft can be distinguished into two types, i. e. (1) when transplanted into the prepharyngeal region, it induces an outgrowth from the host, and (2) when transplanted into the pharyngeal region or a more posterior level, it induces reorganization of tissue and development of new pharynges. Similar phenomena were also observed in our experiments. If the so-called outgrowth referred to above develops on the dorsal surface, it is covered only with the dorsal epithelium, and if on the ventral surface, it is covered only with the ventral epithelium; the epithelium on the other side of the graft becomes enclosed into the interior. The outgrowth developed on the host dorsal surface passes at its base into a cylindrical peduncle which is covered only with the dorsal epithelium. In the ordinary course of events, the peduncle becoming more slender as time passes, the graft eventually comes to be isolated here and falls off from the host. This phenomenon is due, according to GEBHARDT (1926 p. 692), to constriction of a ring which is made of secreted slime. A slime ring coiled round the peduncle of an outgrowth was, in fact, of frequent occurrence in our experiments. Although the slime ring was removed soon after it was formed, the graft head could not in nearly all the cases avoid the fate of falling off. Its cause may not, therefore, be so simple that it can be sought in the constriction of a slime ring. But, if the ventral epithelium is invaginated deep into such an outgrowth and if it is, furthermore, in connection with the host ventral epithelium, the graft head in question never falls off. It does so only in those cases in which the peduncle is barely possessed of the dorsal epithelium. It may be supposed that the dorsal epithelium exerts incessantly a sort of mechanical pressure towards the interior in such a way that the latter causes the peduncle to be constricted. On the other hand, it may be considered that the physiological dominance of the host head inhibits the graft head from developing and leads, furthermore, to the absorption of the latter; but if the physiological dominance were the sole cause, all the graft heads might be led ultimately either to absorption or to falling off. It may also be supposed that responsible here is the absence of nervous connection between the graft and the host, but this point could not be made sure because of our lack of histological observations. In brief, a cylindrical body covered only with the dorsal epithelium, a formation far apart from the original flat condition of planarian organization, is, as a matter of fact, by no means perpetual. On the contrary, an outgrowth formed on the ventral side and covered only with the ventral epithelium never falls off. This may be attributed to the peculiarities of the ventral epithelium in contradistinction to the dorsal, but it may also be supposed that a ventral outgrowth endures because of a connection easily realized between ganglia of the graft head and nerve-cords passing ventrally of the host.

When the dorsal and the ventral epithelia are united each with the corresponding epithelium of the host, no development of the so-called outgrowth occurs. Here new tissue always appears along the line of union, not only, of course, when union is complete, but also even when cut surfaces are partly exposed. Hence when union is complete on all sides, new tissue appears along the whole line of union, an elevation being formed either on the dorsal or the ventral surface with a corresponding depression on the opposite side.

According to SANTOS (1931, p. 159), outgrowth is formed from the graft more frequently on the dorsal than on the ventral surface of the host, since it is more easy for an outgrowth to develop on the dorsal than on the ventral surface because of the lack of resistance offered by the bottom of the vessel. But that in which direction, dorsal or ventral, the graft develops depends, according to our observation, rather on the depth at which the graft is buried at the time of operation.

On the reorganization of host tissue through the head graft, SANTOS (1931, p. 153) states as follows. The development of the postcephalic outgrowth as well as the reorganization of the pharyngeal or the postpharyngeal region does not represent regeneration in the strict sense of the word. The former proceeds much less rapidly than the reorganization of tissue and is not accompanied by any formation of new or embryonic tissue. Still less the reorganization of tissue in the pharyngeal or the postpharyngeal region is regeneration, for it proceeds very slowly without any morphological change of the body, except cell divisions and growth for the formation of new pharynx and for the reconstruction of intestinal canals. SANTOS evidently observed no appearance of new tissue in these cases, but states the fact that in the case of prepharyngeal or pharyngeal graft new tissue appears, and the graft migrates either anteriorly or posteriorly from the level of transplantation. As already stated, it was demonstrated in our experiments that in the case of head graft also, when each of its dorsal and ventral epithelia was brought into normal and complete union with the corresponding epithelium of the host, new tissue always formed along the line of union: in the head grafts with *dd-vv* union, as shown e. g. in fig. 2, new tissue was always observed to appear between the graft and the host, whether or not a cut might have been made secondarily upon the host either anterior or posterior to the graft. Why does not new tissue appear along the line of union, when both the dorsal and the ventral epithelia of the graft are united merely with either the dorsal or the ventral epithelium of the host? It is probably because the postcephalic outgrowth that has been induced through the graft is cylindrical in form, and the graft head itself is radial to a certain extent, i. e. multipolar as SANTOS calls it. In those cases of incomplete transplantation which may be the cause of such an outgrowth, the anterior end of the head is formed on the anterior cut surface of the graft by the union of the dorsal and the ventral epithelia of the graft themselves, while a physiologically anterior end is also formed at the opposite end of the graft, here constituting the so-called heteromorphic head end, the line of union of the graft ventral epithelium and the host dorsal epithelium being taken as the edge. As the physiologically anterior end had thus been occupied exclusively with the old tissue, there was left no more room for the formation of new tissue along the line of union. Within the scope of our results of experiments, in those cases in which the ventral epithelium of the head graft was so united as to be surrounded with the dorsal epithelium of the host, there resulted invariably a biaxial heteromorphic head by the cooperation of the two components of the grafting (figs. 6, 7. 13, 14). Here notwithstanding GOETSCH's account, new eyes are formed as easily in the old tissue of the host as in that of the graft. The appearance of these eyes may be taken for an indication of the biaxiality acquired by the graft head.

The graft head of a cylindrical form which has developed in the host prepharyngeal region and is provided with a peduncle covered only by the dorsal epithelium can not inhibit the head regeneration on the anterior cut surface of the host, when the host head is removed at a level immediately before it. Although one may be allowed to assume that the peduncle represents physiologically a postcephalic or a prepharyngeal region, it can never be adopted in reality as the corresponding region of the host, but a new and separate head is regenerated from the host. Hence, the claim by RAND and BROWNE (1926) can not hold here, that the physiological dominance of the graft head exerts an inhibitory action upon the regeneration of the host head. On the contrary, in those cases of so-called complete union, in which each of the dorsal and the ventral epithelia of the graft head is united with the corresponding epithelium of the host, the head of the host can easily be replaced with that of the graft.

When a head piece is transplanted into the postpharyngeal region and union complete, new tissue appears along the line of union, and at the levels anterior and posterior to it either in the host or in the new tissue two pharynges in opposite direction make their appearance. The polarity of the host tissue anterior to the graft has evidently been reversed. Thus, it may be said with SANTOS that the ganglionic region acts as an organizer for the development of organs, including the pharynx.

The preocular region or the auricular lobe also, when employed as the graft, develops approximately the same as the ganglionic graft, and exerts its influence upon the host in a similar way, but to a lesser extent than the latter.

2. *Prepharyngeal grafts:* When a small piece taken from the prepharyngeal region is transplanted into the postpharyngeal region with complete union, new tissue appears along the lines of union. If a cut is made secondarily along a line of union to expose again a part of the graft, a head is always regenerated from the exposed cut surface regardless of the position of the latter; the effect of the graft on the host is nearly the same as in the preceding case of the head graft, development of new pharynges being induced. When the graft piece is intimately united on all sides with the host, dorsal elevation is formed accompanied with no head development, and yet two pharynges in opposite direction are induced anteriorly and posteriorly to the graft level (figs. 54, 55, 57, 58). These results of experiments suffice to prove that induction of the pharyngeal development is possible without either a head or a brain. It is further shown that such a graft can reorganize that part of the host tissue which is situated anterior to the graft level, causing the polarity of the latter to be reversed. Hence, we know that such a function as to cause the differentiation of organs on the part of the host is not necessarily delimited to the ganglionic region.

3. *Pharyngeal grafts:* If a small piece which is taken from just before the pharynx and yet does not include the original pharynx is brought into the prepharyngeal region, a pharynx develops in the graft. As in this case that portion which intervenes between the pharynx and the intestine is included in the graft, it may be supposed that a pharynx will be regenerated therefrom. Nevertheless, if such a piece is transplanted into the postpharyngeal region, frequently no development of pharynx occurs. Hence, the development of pharynx in the previous case cannot simply be regarded as a process of regeneration, but rather an agent on the part of the host, which may probably be called an impetus for the development of pharynx, must be considered to have played a more important rôle.

In one case in which a small piece including the pharyngeal basis was transplanted into the prepharyngeal region, a pharynx was not only regenerated, but another one also developed in the graft. On the other hand, when a similar piece was brought into the postpharyngeal region, apart from the formation of a mouth opening no influence could be observed either of the graft on the host or vice versa. In the transplantation of a small piece which is derived from the middle of the pharynx, the dependence of the results on the level at which the grafting is made is more conspicuous: when the piece is grafted into the prepharyngeal region, a pharyx is formed there evidently under the influence of the host, but in the case in which the piece is grafted into the postpharyngeal region no organ is caused to develop there. The above facts may be interpreted also as indicating that in the pharyngeal region itself there exists a gradient of differentiation, which is related to the development of pharynx and decreases in strength from the anterior to the posterior end.

4. *Postpharyngeal grafts:* In the transplantation of a postpharyngeal piece there always arises a tail from the original posterior and a head from the original anterior end of the graft. In these cases, the fate of the graft is due to growth of its own, the pharynx also being developed in it. Here will be given some comparison between the head and the postpharyngeal grafts. In the case of the former, the graft does not grow itself, but either induces the development of new tissue in the neighbouring regions of the host or forces this to carry out the reorganization of tissue. In the case of the postpharyngeal graft, it grows itself and induces the development of pharynx in itself. Here it is suggested that the normal growth of a planarian depends always upon the elongation of the postpharyngeal region.

In the cases where a postpharyngeal piece is transplanted into the prepharyngeal region, if union is complete so that the cut surfaces on all its sides are united, the graft develops into a vesicular form (figs. 69, 70, 71); and if union is incomplete, a more prominent outgrowth is formed (fig. 80). There are often cases where an individual worm is completed by the growth of the graft itself (figs. 76, 77, 78). The formation of such abnormal forms is also due to the extension of the graft itself, and in this respect differs much from the formation of the outgrowth in the case of a head graft which consists essentially of a process of extraction from the host tissue.

The results of experiments, in which a posterior piece immediately after fission is taken and a small area near its anterior end is rotated in situ, are very similar to those of experiments, in which a postpharyngeal piece is used as the graft. This is probably because the anterior end of the worm in question is not yet fully advanced in organization, but retains still many of the properties of the postpharyngeal region.

5. *Tail grafts:* When a tail piece is transplanted into the prepharyngeal region, regardless of its orientation, it always develops into a tail and at the same time grows in length. Whether the new tissue which appears in the meantime between the graft and the host is derived entirely from the graft or partly from the host is a question which is not yet settled. But taking into consideration that the pharynx newly formed is always situated near the old tissue of the host, and that the old pigment of the graft is localized near the tail end etc., it can safely be said at least that the tissue which appears between the graft and the host is larger in quantity than that which is produced at the tail end.

II. Change or reversal of polarity in the graft: In a small piece that has been transplanted change or reversal of the polarity often takes place. In the case of a head graft, when both its dorsal and ventral epithelia unite merely with the host dorsal epithelium and a head develops that may vary in form according to cases, its polarity can easily be changed, and eyes are newly formed always in the direction of the head development, either in the graft or on the dorsal epithelium drawn in that direction out of the host. Further, when a head piece is grafted into the prepharyngeal region with reversed orientation and the host tissue before it is removed, a head is formed on its posterior cut surface. In transplantation of a similar head piece into the postpharyngeal region with normal orientation, if the host tail region behind the graft is removed, a head is also formed on its posterior cut surface. Moreover, a head graft is able to develop into a head not only in those cases in which it is transplanted in reversed anteroposterior orientation, but also in those cases in which it is united with the host merely by one of its lateral cut surfaces. In these cases a head is developed from the cut surface on the opposite side. Hence, in whatever region and in whatever orientation a head piece may be grafted, it always develops into a head and never gives rise to any other structure than itself. And the orientation, i. e. the polarity, of the head formed is determined by the mode of union between the graft and the host at the time of operation. Hence, if the graft is united completely on all its sides with the host, the anteroposterior and the mediolateral gradients in the graft being lost, a radial structure, the graft as the centre, is to be produced. New tissue is formed, as already mentioned, around such a head, giving rise here to a vesicular elevation. This is a proof that the graft has become the centre of the new beginning of growth. If the vesicular body is opened by a cut at right angles to the longer axis of the host, an anteroposterior and a laevodextrous relation come to be re-established in the portion consisting of new tissue. But an anteroposterior relation is no longer retained in the head region which has functioned as the centre of growth (figs. 32, 34).

If a rectangular piece cut out from the prepharyngeal region is reunited in situ in reversed anteroposterior orientation and the host tissue anterior to it is removed by cutting, a head develops in almost every case. If a similar piece is transplanted into the postpharyngeal region in reversed orientation and the part of the host anterior to it is removed, a head also develops from the anterior cut surface, i. e. the original posterior cut surface of the graft. Further, if also a similar piece is brought into the postpharyngeal region in normal orientation and the part of the host posterior to the graft level is removed, a head develops from the posterior cut surface. In these three cases the direction in which the head develops is clearly reversed in relation to the polarity of the grafted piece. This is probably because the potency of head formation within the small piece is very much dominant over the surrounding host tissue.

If a small area in the prepharyngeal region is rotated in situ and the host posterior part is removed, in most cases a head, but occasionally a tail, develops from the posterior cut surface, i. e. the original anterior cut surface of the small piece. In the latter case where a tail develops the polarity of the graft has come to be reversed. Hence, it may be said that in the prepharyngeal region reversal of the polarity is a comparatively easy matter, either a head or a tail being formed according to cases. But, here much influence seems to be exerted by the power of regeneration of the host tissue neighbouring the exposed cut surface of the graft on one hand, and by the level at which transplantation is made on the other.

As in our experiments of transplantation of the pharyngeal pieces no secondary cut was performed, we were not in a position to find out anything about the change of polarity at the time of their regeneration. But whether the graft may be placed with normal or reversed orientation, its influence on the host is almost the same, no difference in the results being observed with regard to its orientation. Therefore, it becomes rather doubtful whether the original polarity of the graft is still preserved after transplantation.

But change of the polarity rarely occurs in the postpharyngeal graft, from which in most cases in accordance with its original polarity either a head or a tail is regenerated. This fact can be attributed not simply to any characteristic of this region to preserve the polarity of its own, but to the tendency for tail formation which is particularly strong on the posterior cut surface of the graft itself. For the polarity of this region as a whole can easily be reversed, as is known, by grafting therein a head or a prepharyngeal piece. In brief, the tissue of this region is provided with so much tendency towards elongation, that when transplanted into other regions it appears very obstinate to preserve its polarity.

In the case of a tail graft a tail always develops either from its anterior or from its posterior cut surface. Even if it is transplanted at a considerably anterior level of the host, formation of a head under the influence of the latter can seldem occur.

Santos (1931, p. 158) stated that the polarity of the graft was preserved in most cases of transplantations in planarians. In his experiments equilateral triangular pieces, most of which were elongated anteroposteriorly, were used as grafts. Hence, it seems that the form and the length were probably sufficient for the graft to preserve the polarity of its own.

III. Formation of new tissue and morphological organization: Although it was contended by Goetsch (1929), Child (1929) and Santos (1929, '31) that a head piece, particularly one including the brain, functions, on being grafted, as the source for morphological differentiations on the part of the host, yet a piece other than the ganglionic, e. g. a preocular or an auricular, when used as the graft, exerts also a similar influence upon the host (p. 395). Further, when a prepharyngeal piece is transplanted into the postpharyngeal region and united on all sides, whether a head regenerates or not, it also acts upon the host tissue as an organizer and induces development of new pharynges (p. 401). Hence, what can function as an organizer is, it is clear, by no means restricted to the ganglionic region. But the capacity for organization is evidently in different degrees, the difference being directly manifested in the distance between the graft and the new pharynx induced, and the ganglionic region proves in such a manner to be the strongest organizer.

When any two portions of planarians are united, formation of new tissue either occurs or not. That is, if two portions which have come to be joined together are derived from different levels of the body and lack something either morphological or histological which is to intervene between them, new tissue always appears. Such an example was already given also by LI (1928), who deprived an planarian of its pharyngeal region and made·the anterior and the posterior portions thus derived reunite in their original orientation.

GOETSCH (1921) considers that the regeneration may be attributable to the lack of either the anterior or the posterior portion of the body, and that "Verwachsung" inhibits regeneration. On the other hand, LI maintains that the presence of a cut surface does not represent an indispensable condition for regeneration, and that the cause for inhibition of regeneration in the case of the heteropolar union of two tail pieces is to be found not in "Verwachsung" itself, but in the heteropolarity at the time of "Verwachsung". But through the results of our experiments it is shown that these conditions which were set forth hitherto still do not suffice. For, in a case of heteropolar union of two planarian pieces where a prepharyngeal piece is chosen as one component and a postpharyngeal piece as the other (p. 421), new tissue also arises along the line of union and a pharynx is induced to develop. Thus, in the cases where the so-called "Reiz der Fehlenden" of GOETSCH is put out of place, as also in the cases where a heteropolar union as claimed by LI takes place, the formation of new tissue does occur, either of the suppositions of the above authors notwithstanding. On the contrary, if two prepharyngeal pieces are united with each other in reversed orientation, i. e. by their posterior cut surfaces (p. 423), or similarly if two postpharyngeal pieces are brought into a heteropolar union with each other by their anterior cut surfaces (p. 423), no new tissue regenerates along the line of union. In these cases it is observable only that both components gradually decrease in width increasing at the same time in length. It may be inferred from the above that the very cause for the formation of new tissue is the lack, between the cut surfaces of two parts to be united, of some portions that ought to be present in a normal worm. On the other hand, inhibition of this type of regeneration may be taken for a proof that there are no parts physiologically lacking between two components. In other words, when union occurs between two worms at the level which corresponds to each other, no regeneration can take place along the line of union. It is here beside the question, whether the union between two components may be homo- or heteropolar. Hence, the formation of new tissue implies a lack in a physiological or morphological sense between the cut surfaces which have been brought into union. Further, as regards the direction in which proliferation occurs and the polarity of the new tissue, the prepharyngeal region is always taken as the anterior and the postpharyngeal as the posterior end. This fact is more clearly demonstrated in those experiments (figs. 105, 106, 107, 108) in which a prepharyngeal region is brought posteriorly into a homopolar union with a postpharyngeal region. In these cases the polarity of the new tissue is reversed in spite of the homopolar union of the two components. It cannot here be decided within the scope of our experiments, whether the new tissue is derived from one or from both of the components.

Through the results of our experiments in *Planaria gonocephala*, it is confirmed that an anterior part has always an effect as an organizer upon more posterior parts, this power being continually decreases from the head end towards more posterior levels.

GOETSCH (1929) states that a highly specialized graft has a power, when the host head removed, to make the host tissue differentiate. Here, according to his opinion, not the entire body of the host is affected, but those undifferentiated or changeable elements which have been drawn out by the graft (e. g. a head piece) come to be reorganized. But it is evidently proved by SANTOS (1929, '31) that the regions originally present can be subjected as an entirety to a change of polarity.

It was noticed by CHILD (1929) that when regeneration occurs from a planarian piece, the source for the organizing action is localized at the head that has been regenerated. That is to say, the determination of the head is the first to occur at the time of anterior reconstitution of a planarian piece that has been amputated, and the head thus formed induces the development of the more posterior regions. A piece taken from the prepharyngeal region may not occasionally suffice for the regeneration of a head, but it is able to induce the development of a pharynx in the following regions and also the reconstitution of the intestine. A postpharyngeal piece, however, can induce neither the development of a pharynx nor that of prepharyngeal organs, unless regeneration of a head occurs in advance. But it can regenerate such regions that are situated posterior to itself. If such a regenerating piece contains in itself a small quantity of either the prepharyngeal or the pharyngeal tissue, it can induce the development of a new pharynx and a mouth, though not of a head. Thus, it is claimed that the law of anteroposterior differentiation can also be applied to the reconstitution of organs in planarians.

In the experiments of transplantation also, it is absolutely necessary for the development of new pharynx or pharynges that a prepharyngeal part should be united with a postpharyngeal part. This furnishes a direct proof for CHILD's theory. Whether the components may be united in normal or reversed orientation, or whether they may come to be united side by side, so far as one of them is derived from the prepharyngeal and the other from the postpharyngeal region, a pharynx always develops between them. These facts are evident in the light of the results of our experiments which are arranged in the last category. But, that the formation of new tissue does not represent necessary preliminaries for the development of pharynx can be seen from the fact that when the pharynx is excised from a normal worm, or that when two longitudinally cut halves are brought into a heteropleural reindividualization, a new pharynx is formed without accompaniment of any formation of tissue along the line of union.

To sum up, new tissue does not appear when union occurs between two corresponding levels of the worm body, but it does appear along the line of union when union occurs between two different levels which are at some distance from each other. The amount of tissue newly formed is larger in proportion to the original distance between two cut surfaces to be united, as such is also the case with the organizing capacity. With this reasoning such a phenomenon as the elevation or the invagination at the level of transplantation can easily be explained. Furthermore, the problem as to what causes the migration and also what determines the direction in which the graft migrates, the problem which SANTOS (1931, p. 158) left unsolved, will also prove to be self-evident. He expresses his opinion that the backward migration of a pharyngeal graft which has been transplanted in reversed orientation is due not only to the pressure of the new tissue formed there, but also to another factor finding in the process of transplantation itself. But from our point of view, it is nothing but a natural result from the fact that the graft is pushed from the level of production of a larger quantity of new tissue towards that of smaller.

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POSTSCRIPT

As the results of our present study were going to press, SCHEWTSCHENKO's paper was published*. He transplanted a rectangular piece including the brain into the postpharyngeal region after it was rotated either anteroposteriorly (Serie I) or transversally (Serie II). When union occurred on a cut surface which was now set posteriorly (in other words, either at the anterior end or on one of the lateral sides of the graft), a head developed in the direction either reversed or at right angles to the original polarity of the graft. Similarly, in the case of union occurring at both anterior and posterior ends of the graft (Serie III), two heads were formed in directions other than the original. In both cases a peduncle corresponding to the postcephalic region was formed out of the tissue which was drawn out from the host.

The above results are nothing more than those of cases which are included in our present report under the heading "Incomplete union" in Experiment 2; "Transplantation of the ganglionic piece into the postpharyngeal region". It was already shown by SANTOS and is also clearly demonstrated in our experiments that such a graft including the brain is in itself so qualified that no matter into what region, except the cephalic, it may be transplanted, it always develops into a head, the direction in which transplantation is made remaining here beside the question, for a new head always begins to develop from that cut surface which is left free. That the anterior cut surface of the graft comes to be united, while a head is formed at the other end, is a phenomenon, as a matter of course, opposed to the polarity of the graft itself. Regarding this problem, the polarity reversal of the graft, ample discussion is given in the second item (p. 433) of the chapter of conclusion in our paper.

One of SCHEWTSCHENKO's results which is not in accord with ours is the case in which an independent worm resulted with a tail derived from the graft. This, however, probably represents a differentiation from that portion which is drawn out from the host. He further states that new eyes are formed only in newly formed tissues, but not in old ones. Concerning this question we have already testified to the incompleteness of observations to which GOETSCH owes his similar proposition. SCHEWTSCHENKO makes, finally, no reference to the induction of pharyngeal development in his account of transplantations of such a ganglionic graft into the postpharyngeal region. Was the reversal of polarity restricted in his cases within the so-called outgrowth drawn out by the graft piece, or did the change of polarity in general not extend, the level of transplantation as the centre, over the whole tissues of the graft, as was observed as well in the experiments of SANTOS as in ours?

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* Zool. Anz., Bd. 115 (1936) pp. 232–244.

19. La Stolonisation et les Caractères sexuels du Stolon chez les Syllidiens Polychètes
(Études sur les Syllidiens III)

Par Yô K. Okada
Université Impériale de Kyoto

(Avec la planche XXIII et 30 figures dans le texte)

INTRODUCTION

Ce n'est pas une chose extraordinaire chez les animaux invertébrés qu'en cas de reproduction asexuée par scissiparité transversale la partie postérieure du corps forme une tête avant de se séparer de la souche et que deux individus alliés viennent à se constituer ainsi. On en trouve de nombreux cas aussi chez les Polychètes. Cependant la reproduction scissipare ou schizogamie chez les Syllidiens faisant l'objet de ce mémoire diffère un peu de celle chez d'autres tribus; sauf un cas particulier, tel que la fragmentation chez les *Syllis gracilis* et *Procerastea Halleziana*, la schizogamie ne vise pas directement la production des nouveaux individus, et dans le cas où l'animal fait une reproduction sexuée, elle a le rôle de charger et répartir les éléments sexuels. Il existe donc une certaine différence de structure entre l'ancien et le nouvel individu. Dans ce cas, les rapports entre le corps-mère ou souche et le stolon ou zooïde peuvent être comparés à ceux entre le polype et la méduse chez les Coelentérés. De même que la méduse est une métamorphose fonctionnelle du polype, le stolon se développant en une Syllide se transforme pour accomplir sa fonction spéciale de reproduction: les changements les plus caractéristiques sont la transformation des parapodes en nageoires, l'apparition des soies natatoires, l'indication des caractères sexuels secondaires dans la région céphalique, etc. Sauf cette métamorphose fonctionnelle des nouveaux individus, la stolonisation chez les Syllidiens ne diffère point de celle chez d'autres tribus de Polychètes. La caractéristique de cette tribu, si l'on veut la chercher, serait la formation d'une chaîne de stolons chez les genres *Autolytus* et *Mirianida* ou l'arrangement des stolons en faisceau chez certaines espèces du genre *Trypanosyllis*. Mais en suivant inversement les stades de leur développment, on peut réduire cette stolonisation particulière à une forme primitive qui est la division du corps en deux parties, antérieure et postérieure. D'autre part, la ramification du corps de la *Syllis ramosa*, qui est souvent citée comme le bourgeonnement le plus étonnant n'est, au point de vue de la stolonisation, qu'une division très simple provoquée indépendamment et simultanément sur chacune de ses nombreuses branches.

Or, depuis que O. F. Müller (1788) avait dessiné un petit ver, sa *Nereis* *prolifera*, en voie de division, ce mode de reproduction des Syllidiens a intéressé de plus en plus les biologistes européens et aussi américains qui ont publié à plusieurs reprises de nombreuses observations intéressantes. De St.-Joseph (1886), en étudiant la schizogamie surtout des genres *Autolytus* et *Myrianida*, a donné un coup d'oeil sur la reproduction asexuée des espèces connues jusqu'alors. Malaquin (1893), s'appuyant sur une base plus large, a décrit la schizogamie des Syllidiens en général; grâce à lui, le mode de reproduction chez cette tribu a été bien mis en évidence. Ensuite, Potts (1911) a fait une révision générale de la reproduction des Syllidiens, en y ajoutant de nouveaux faits qu'il a recueillis pendant 16 ans de recherches consécutives à celles de Malaquin. Il serait donc superflu de renouveler ici les faits déjà connus en remontant au delà de cette époque. Cependant, il faut remarquer que les descriptions gégérales de Potts ont été presque toutes basées sur les observations des autres auteurs; d'ailleurs bien que ces observations fussent incomplètes ou erronées en elles-mêmes, il les a citées en partie telles qu'elles étaient. Il semble qu'il ait établi trop de modes de reproduction pour cette seule tribu de Polychètes et qu'il n'ait pas bien éclairé les relations entre eux.

Le but de ce mémoire est de reviser ces différents modes de reproduction asexuée et de les mettre en bon ordre. Tous les faits formant la base de cette description s'appuient uniquement sur mes propres observations, sauf le bourgeonnement ventral de certaines espèces de *Trypanosyllis*, observations qui ont été faites pour la plupart au cours de mon séjour d'environ un an à Plymouth en Angleterre, de juin 1927 jusqu'au mois d'avril 1928 et pour le reste dans le Laboratoire Maritime de Séto qui est sous ma direction et attaché à l'Université de Kyôto. En en publiant les résultats, je tiens à exprimer mes remerciements sincères à Monsieur le docteur E. J. Allen, chef de Laboratoire à Plymouth, ainsi qu'à tous ses collaborateurs qui ont bien voulu m'accorder toute facilité et le matériel nécessaire à mes études expérimentales.

MODES DE STOLONISATION

A. Stolonisation chez les Syllidés

La stolonisation de la *Haplosyllis sponicola* est caractérisée par le fait que les éléments sexuels remplissent presque tous ses segments à partir de la partie presque pharyngienne jusqu'au segment anal et que la division est limitée à une petite région postérieure du corps (fig. 1). En plus, le second individu ne produit jamais de tête; c'est pourquoi, lorsqu'on parle de la stolonisation des Syllidiens en général, on en considère cette forme comme la plus rudimentaire, malgré le changement remarquable des segments. Quant à la reproduction de cette espèce, on trouve une description bien détaillée chez Albert (1886). Avant la séparation d'un stolon, les éléments sexuels mûrissent jusqu'aux deux tiers de la partie postérieure du corps, et la coloration de cette région varie suivant les sexes: pour les femelles elle est d'un violet clair, tandis que pour les mâles elle est d'un blanc opaque ou d'un rose clair. Cependant, chez les derniers la partie qui se sépare comme stolon est nettement distinguée de la souche, à cause de la pigmentation violet foncé apparu dans l'épithélium du corps. De plus, dans cette région postérieure on voit s'agrandir des parapodes en forme de nageoires, et ensuite se produire un long faisceau de soies natatoires sur la face dorsale. D'autre part, un point noir existant à la base de chaque cirre dorsal augmente de plus en plus de volume; l'épithélium s'épaissit, présente la forme de lentille cristalline et constitue ainsi une sorte d'oeil. Par contre, le cirre dorsal lui-même se réduit plus nettement qu'auparavant. Dans la structure interne, on remarque une diminution du canal alimentaire et une dégénérescence considérable des muscles dorsal et ventral longitudinaux des parois du corps. Or, par suite de l'accroissement des parapodes et de leur nouvelle fonction natatoire, les muscles spéciaux prennent un grand développement. La dégénérescence de l'intestin et des parois du corps fournit, en revanche, des matières nécessaires au développement des éléments sexuels, d'une part, et cède la place au remplissage des oeufs ou spermatozoïdes, d'autre part. Un autre changement de la structure interne plus marqué chez les mâles est le développement intense des néphridies pour le transport des spermatozoïdes. Cet organe prend en se développant une coloration spéciale et on en aperçoit facilement les contours même par la face extérieure du segment, mais chez les femelles on ne constate pas de développement des néphridies correspondantes. Il semble que la ponte s'effectue aux dépens de la rupture du segment. Au moment de la séparation du stolon, on voit s'écouler au moins un petit nombre d'oeufs par la plaie de l'extrémité postérieure de la souche.

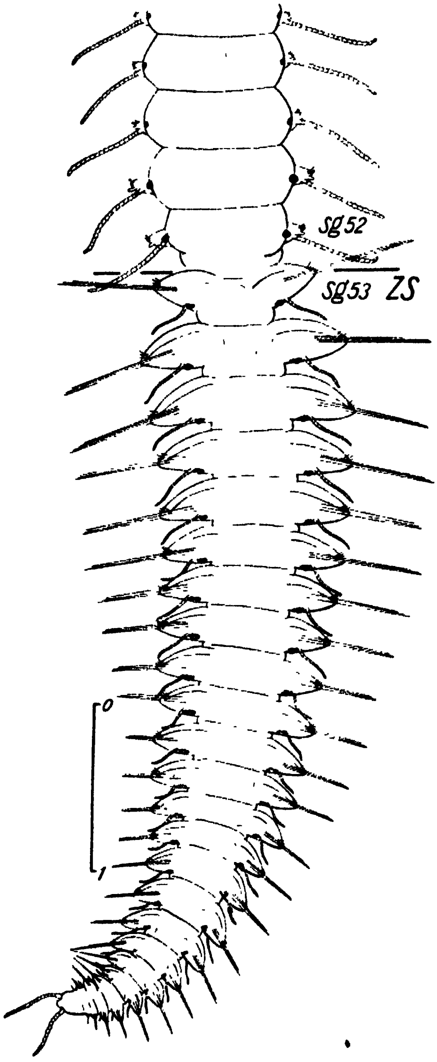

Fig. 1. Région postérieure de *Haplosyllis spongicola* observée avant le détachement du stolon mâle.

Affectée de tels changements, la partie postérieure du corps se montre à l'extérieur de l'éponge dans laquelle le ver vit en parasite, et celui-ci continue des mouvements vibratoires. Pendant ces mouvements vibratoires la partie

Tableau I

Tableau synoptique de la stolonisation chez la *Haplosyllis spongicola*.

Numéro des spécimens		1	2	3	4	5	6	7	8	9	10
Sexe		♀	♂	♂	♂	♀	♀	♂	♂	♀	♂
Limite antérieure des segments génitaux		18 me	—		19 me	24 me	-	—	—		?
Ordre des segments dans la souche comptés de l'extrémité postérieure	10								++		
	9								++		
	8								++		
	7								++		
	6						++		++		
	5				++		++		• •		
	4				++		++		• •		
	3			++	• •		++	++	• •	++	
	2			++	• •		++	•	• •	++	
	1			++	• •		++	• •	• •	++	• •
Niveau de séparation; Entre les segments		38 39	43-44	50-51	52-53	55-56	65-67	67-68	69-70	73-74	
Ordre des segments dans le stolon comptés de l'extrémité antérieure	1		• •	?	• •	• •					• •
	2		• •		• •	• •					• •
	3	+ •	• •		• •	• •					• •
	4	• •	++		• •	• •					• •
	5	• •	++		• •	• •					• •
	6	• •	++		• •	• •					• •
	7	• •	++		• •	• •					• •
	8	• •	++		• •	• •					• •
	9	• •	++		++	• •					• •
	10	• •	++			• •					
	etc	• •	++			• •					
Nombre de segments dans le stolon		21	21		15	20	R	R	R	R	15

• • signifie l'élargissement des taches pigmentaires à la base du cirre dorsal, ++ la présence des taches semblables moins développées. R, désigne l'extrémité postérieure du ver en régénération.

postérieure se divise comme un stolon ; le mâle, aussitôt libéré, nage vivement dans l'eau ; la femelle a des segments bien enflés et remplis d'oeufs, et probablement à cause de la métamorphose des parapodes moins complète que le mâle, elle nage habituellement à peine, même après sa séparation.

Le corps-souche laissé dans l'éponge reproduit les segments postérieurs perdus par la séparation d'un stolon. La régénération se fait suivant le mode qu'on observe généralement chez les Polychètes : l'extrémité de la queue est formée d'abord, la zone de prolifération ensuite, et celle-ci est peu à peu entraînée en arrière en formant de nouveaux segments d'avant en arrière ; avant la prochaine stolonisation, le nombre des segments perdus sera presque rétabli, mais il n'est pas sûr que la nouvelle division s'effectue au même niveau que l'ancienne, et parfois elle se manifeste deux ou trois segments plus en avant. Les parapodes qui n'ont subi aucun changement dans la première division éprouvent cette fois-ci le même sort que les segments qui les suivent. En examinant avec un peu de soin les segments qui contribuent à la formation du stolon dans la prochaine division au point de vue de l'avancement du niveau de séparation, on constate souvent que l'ébauche des soies natatoires, le point noir à la base du cirre dorsal, etc. s'y développent plus intensivement que sur les autres segments.

Il semble que le phénomène de séparation soit dû à une compression

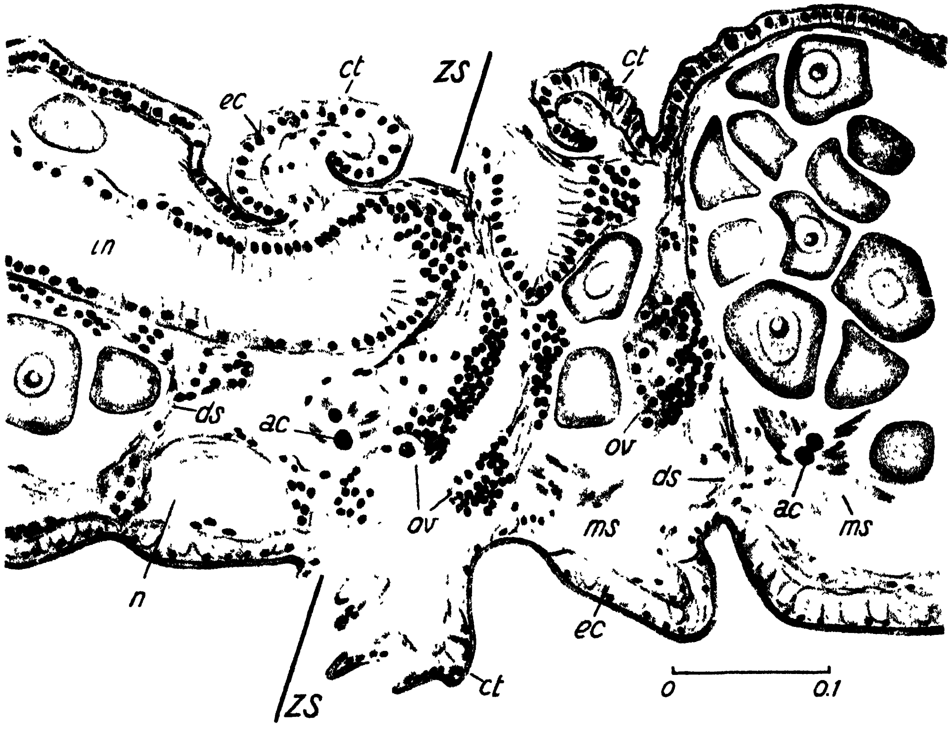

Fig. 2. *Haplosyllis spongicola:* Destruction de la paroi du corps au niveau de détachement du stolon (ZS).

antérieure et postérieure des éléments sexuels qui remplissent les segments de la souche en avant et ceux du stolon en arrière de la position spéciale et aussi à un mouvement vibratoire continuel du dernier. La division commence par la rupture de la cuticule et de l'ectoderme de la face dorsale et provoque l'exposition des organes internes (fig. 2). La destruction des segments se propage de la face latérale vers la face inférieure et la division s'achève alors. Il faut bien remarquer que le dissépiment est surtout parfait dans cette région de division, tandis que les glandes génitales y restent en état rudimentaire; ce serait pour fournir des matières à la nouvelle production des segments qui se manifeste après la séparation du stolon. On voit que chez le spécimen montré dans la figure 2, les trois segments représentant la région de division sont agglomérés presque en un endroit, à cause de la compression des éléments sexuels (des oeufs dans ce cas) contenus dans les autres segments qui les précèdent et qui les suivent; la rupture de la cuticule et de l'ectoderme de la face dorsale y est nettement observée.

Le stolon est acéphale et possède de 15 à 23 segments sétigères et un pygidium. Outre la coloration des segments expliquée plus haut, la distinction sexuelle du stolon s'observe souvent d'après le fait que chez le mâle la constitution du corps est généralement plus légère et la métamorphose de segments plus accentuée que chez la femelle, et que surtout le développement des néphridies ne se rencontre que chez le premier.

Ce que je viens d'expliquer ci-dessus est un aperçu général sur la stolonisation chez la *Haplosyllis spongicola*. La *Typosyllis cirropunctata* suit le même mode de stolonisation. Cette dernière espèce fut découverte à Naples par Michel (1909), et depuis elle ne fut jamais trouvée ailleurs. Cependant, il y a quelques années, j'en ai obtenu quelques spécimens à Séto et observé deux d'entre eux en voie de stolonisation. C'étaient deux mâles: l'un de 17 millimètres de long possédait une tête, 88 segments sétigères et un pygidium, et le stolon se formait entre les segments 65 et 66; l'autre un peu plus court avait une tête, 74 segments sétigères et un pygidium, et la stolonisation était en voie de manifestation entre les segments 60 et 61. Dans ces deux cas, de même que dans le cas de *Haplosyllis* précité, les segments du stolon se différenciaient nettement de ceux de la souche qui les précédaient, par la transformation des parapodes en nageoires, le prolongement des soies natatoires, l'apparition des granules pigmentaires dans l'ectoderme, etc.

J'ajoute ici que la *Typosyllis cirropunctata* japonaise, en comparaison du type originel de Michel, est caractérisée par l'absence de taches pigmentaires sur le dos; il est certain que ces deux types sont d'une même espèce, n'ayant pas d'autres différences entre eux.

Les stolons des deux types précités n'ayant pas de formation de tête, on considère cette stolonisation comme primitive, mais si l'on traite cette question en s'appuyant uniquement sur leur état au moment de la séparation, sans tenir compte des changements futurs, on en trouvera la forme primitive plutôt chez la *Typosyllis armillaris* rapportée par Malaquin (1893 p. 333). Chez cette espèce, à l'approche de l'époque de la reproduction, les segments postérieurs contenant des éléments sexuels présentent une coloration caractéristique suivant les sexes et augmentent de volume en même temps; la division est provoquée avant qu'ait lieu la transformation des parapodes en nageoires, constatée dans le cas précédent. Il va de soi qu'après la séparation du stolon le corps-souche reproduira les segments postérieurs perdus. D'autre part, la partie postérieure qui s'en est détachée entraîne aussi une régénération de tête après quelques jours de repos et elle est également suivie de métamorphose des segments y compris le changement des parapodes en nageoires et l'apparition des soies natatoires; elle se développe ainsi en un individu nageur du type *Ioda*. Cependant, au moment de sa séparation, c'est nettement une division typique c.-à-d. une achitomie qui se réalise.

Alors, pourquoi la formation de tête dans le stolon détaché n'a-t-elle pas lieu chez la *Haplosyllis spongicola?* Comme il a été rapporté par l'auteur (Okada 1929 a p. 578), cette espèce même a vraiment la faculté de régénérer la tête, mais il semble que dans le stolon la métamorphose des segments soit trop intense avant sa séparation et qu'il lui soit impossible de vivre longtemps. Dans ces conditions, purquoi la formation de tête ne se manifeste-t-elle pas dans la région de division avant la séparation? Cette dernière question revient en somme à chercher les causes de la paratomie chez la *Typosyllis prolifera* et chez d'autres espèces que nous allons décrire ci-dessous. Malheureusement, nous n'avons pas les documents nécessaires à l'éclaircissement de ces causes et nous nous bornons à affirmer ici qu'un stolon gravement atteint de changement des segments diminue de plus en plus sa faculté régénératrice et finit par la perdre complètement.

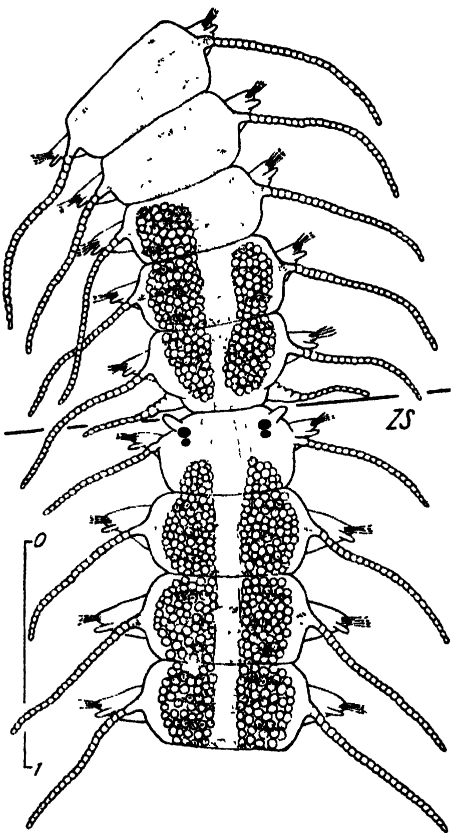

Fig. 3. Pièce médiane de *Typosyllis prolifera* avec la tête de stolon dans une position un peu en arrière de la limite antérieure des segments génitaux.

Chez la *Typosyllis prolifera* l'apparition des éléments sexuels est localisée dans la partie relativement postérieure du corps, par conséquent la région génitale et le nombre des segments destinés à se séparer s'approchent l'un de l'autre; la partie sexuée du stolon et la partie asexuée de la souche se distinguent. Il est bien entendu que ces deux parties ne sont pas strictement limitées; pour la femelle il reste presque toujours deux segments et demi génitaux en avant du niveau de division (fig. 3) et pour le mâle cinq ou six segments.

De plus, en comparison du cas précédent, ce cas montre un grand progrès en ce que la tête se produit dans la partie postérieure et la queue dans la partie antérieure, avant que le stolon se détache de la souche, mais que, d'autre part, la métamorphose des parapodes et le développement des soies natatoires sont bien plus retardés ici que dans le cas de *Haplosyllis*; pour cette raison, le stolon détaché n'est pas encore apte à nager dans l'eau, au premier moment de sa séparation.

La différenciation sexuelle de cette espèce est pareille à celle de la *Haplosyllis*. La femelle présente un violet clair par la coloration des oeufs qu'elle renferme, et on voit chacun de ses segments s'épaissir beaucoup. Par contre, le mâle a une structure légère et accumule dans les parois du corps des granules pigmentaires d'un violet foncé ; une paire de néphridies apparait nettement dans chaque segment. La structure interne de cette espèce est aussi à peu près semblable à celle de la *Haplosyllis*.

C'est le mode de reproduction des segments postérieurs qui est le plus caractéristique dans la stolonisation de cette espèce : une petite queue se produit à l'extrémité postérieure de la souche avant la séparation d'un stolon. Dans ce mode bien différent de celui de régénération caudale qu'on rencontre ordinairement, un demi-bourgeon de queue est formé à part à droite et à gauche, et leur soudure médiane ne sera jamais réalisée à moins que le stolon en arrière ne se sépare de la souche (figs. 4–10). En même temps que se produit

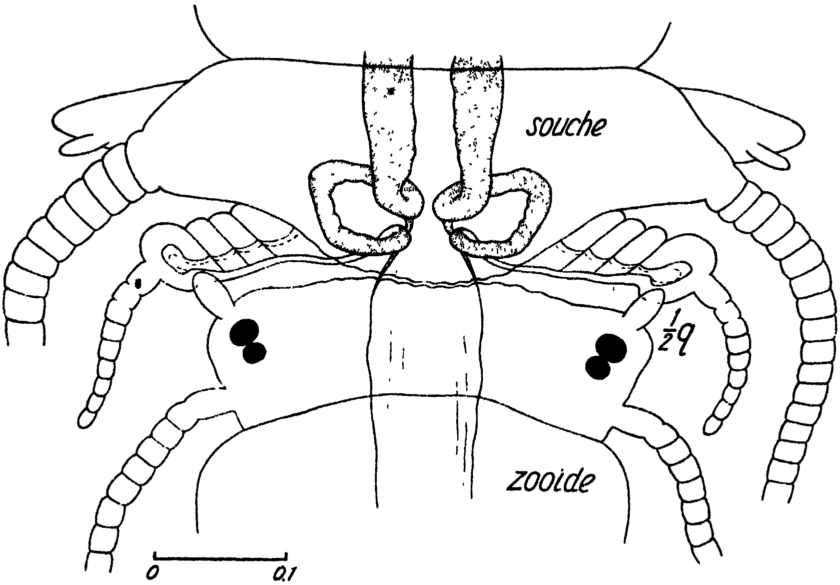

Fig. 4. *Typosyllis prolifera:* Tête du stolon et le segment de la souche la précédant en plus de magnificence; un demi-rudiment de la queue ($\frac{1}{2}$ *q*) est produit sur chaque côté de l'extrémité postérieure de la souche.

la séparation du stolon, les deux demi-bourgeons viennent se souder en se déplaçant de la face latérale vers la face ventro-médiane et former ainsi une queue complète. Cette curieuse régénération caudale a été déjà rapportée par Michel (1909) et par moi (Okada 1929 a). Le demi-bourgeon est dû à un accroissement latéral du dernier segment de la souche ; par conséquent, au début de son apparition, il n'est qu'un bourrelet des parois du corps, mais lorsqu'il s'est développé un peu, il forme une couche régulière de grosses cellules en face de la tête du stolon en arrière et quelques couches de cellules plus petites du bas en avant ; on voit se former de jeunes cellules mésodermiques indifférenciées entre ces deux sortes de couches ectodermiques (Okada 1929 a, fig. 6, p. 551). La couche de grosses cellules en arrière de deux demi-bourgeons, lorsque ceux-ci se soudent l'un à l'autre, formera l'intérieur des segments caudals et pourra se réunir avec le canal alimentaire de la souche. Cependant, tout l'intestin de ces segments caudals nouvellement formés n'est pas toujours d'origine ectodermique. Avant la séparation du stolon, l'intestin présente déjà dans la partie postérieure de la souche, un accroissement considérable vers

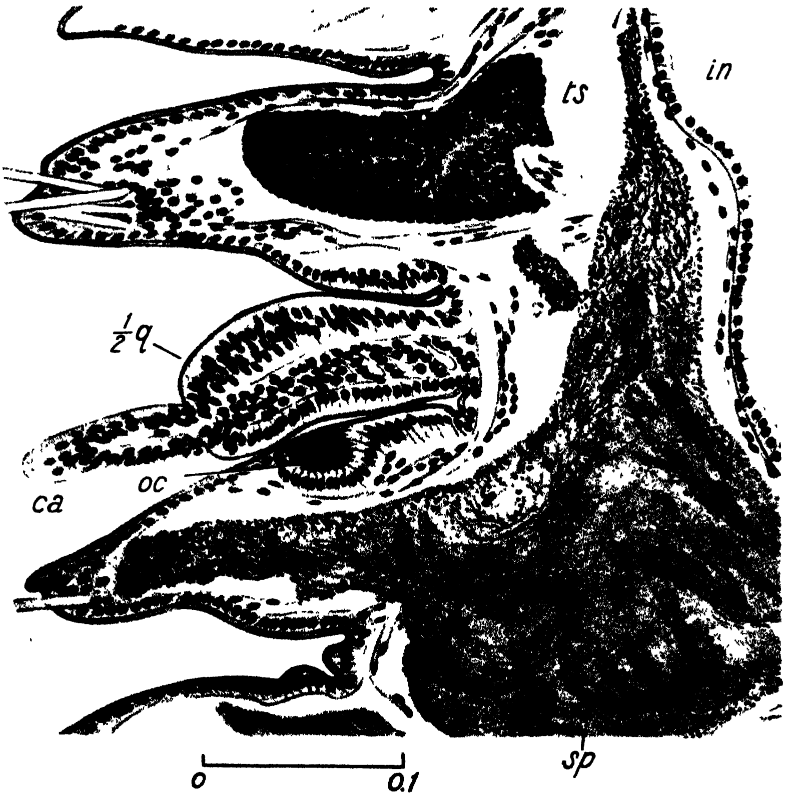

Fig. 5. Moitié gauche d'une section horizontale de *Typosyllis prolifera* dans la position où se joignent deux individus, la souche en avant et le stolon en arrière ; le demi-rudiment de queue (½ *q*) est montré en section longitudinale.

deux faces inféro-latérales (fig. 4), et avec la séparation du stolon, il est repoussé en dehors du segment en forme de hernie (fig. 8). C'est donc cette couche cellulaire qui participe à la formation intestinale de la queue en régénération, et la partie qu'on croit en effet d'origine ectodermique est limitée à une petite région relativement postérieure ; les cellules ectodermiques ne contribuent qu'à la formation du proctoderme, la grande partie du canal alimentaire étant toujours d'origine endodermique (figs. 8, 9, 11).

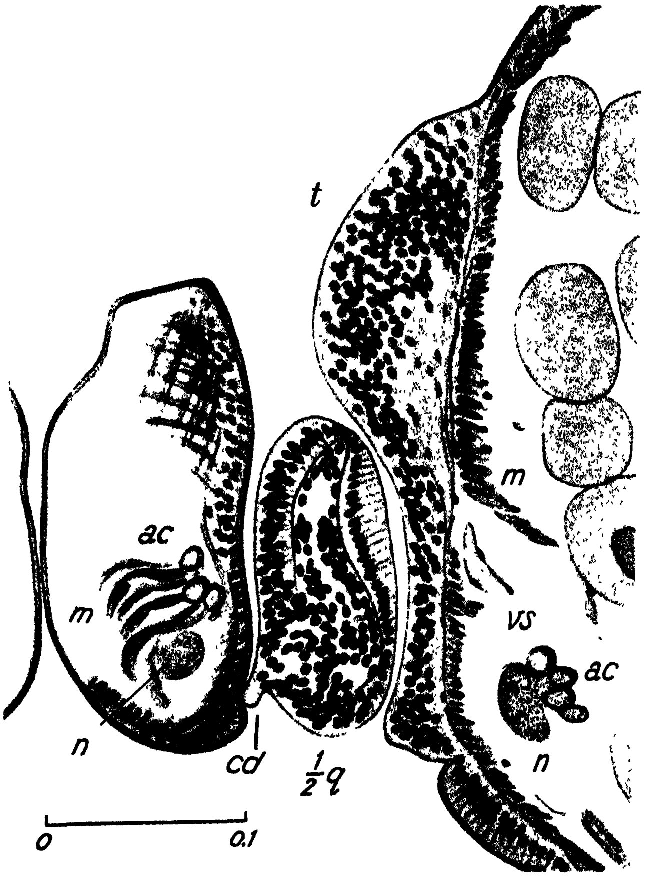

Fig. 6. Section longitudinale de *Typosyllis prolifera* dans la même position que dans la figure précédente; le demi-rudiment de queue ($\frac{1}{2}q$) est montré en la section transversale. *t*, tête du stolon.

La soudure des deux demi-bourgeons de queue à droite et à gauche commence par la face ventrale en se dirigeant d'avant en arrière et elle est toujours retardée à la face dorsale ; surtout elle ne se produit jamais à l'extrémité postérieure et y laisse une fosse romboïdale qui deviendra l'anus de la nouvelle queue (figs. 9, 11). Quoique le système nerveux soit formé séparément à droite et à gauche de l'ectoderme de la face inférieure de chacun des demi-bourgeons, il fait voir nettement sa différenciation remarquable après la soudure de ces derniers (fig. 10). La couche de cellules mésodermiques manifeste à l'intérieur beaucoup de segmentation depuis son apparition (fig. 5). Cependant, au moment de la séparation du stolon, on n'y voit que trois segments en outre du pygidium (fig. 7). La production des parapodes, des soies natatoires, des muscles, des glandes, etc. ne diffère point de celle qu'on constate dans la régénération en général (fig. 10).

Dans la stolonisation de cette espèce la formation de la tête du stolon est bien souvent localisée entre les segments 35 et 36 ou 36 et 37, comme le tableau II le montre, mais ce niveau de division n'est pas très constant et ordinairement il s'avance plutôt dans la deuxième division que dans la première. Surtout lorsque l'extrémité céphalique est amputée à un ver en voie de stolonisation, on observe souvent qu'il reproduit la tête du deuxième stolon dans une région bien antérieure, avant de récupérer ses segments postérieurs perdus du fait de la séparation du premier stolon. Dans un cas extraordinaire, comme la figure 12 le montre, le ver formait déjà, avant de manifester une régénération postérieure, la tête

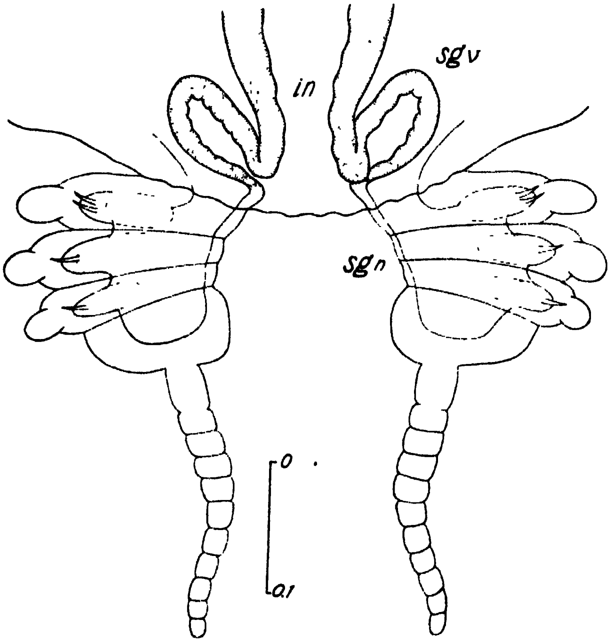

Fig. 7. *Typosyllis prolifera:* Le stolon est détaché et les demi-rudiments (latéraux) de queue sont déplacés vers la position postéro-médiane. Il y a 3 segments (*sgn*) dans chaque rudiment.

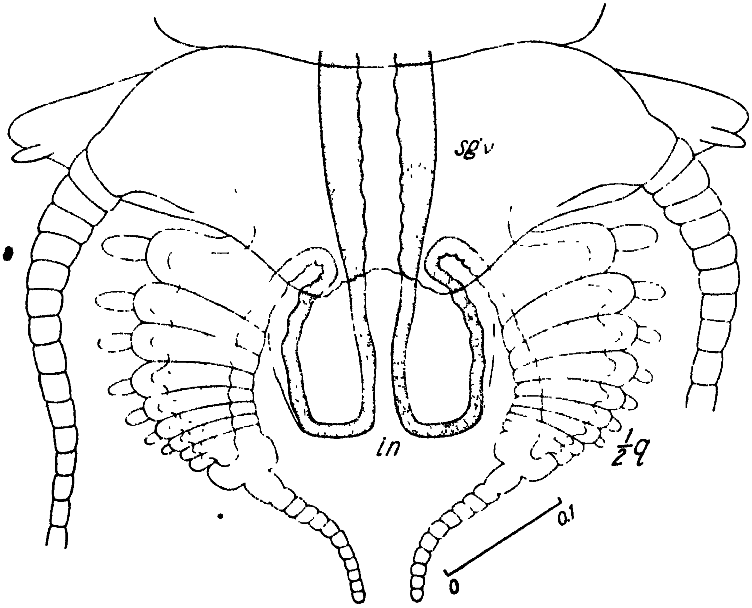

Fig. 8. Etat plus avancé de la régénération caudale de *Typosyllis prolifera* que dans la figure précédente. Il y a environ 10 segments sur chaque côté et l'extrémité de l'intestin (*in*) fait saillie à l'extérieur comme une hernie entre deux demi-rudiments de la queue.

du deuxième stolon à un niveau plus avancé de sept segments que celui de la division précédente et le stolon formé n'avait donc que les sept anciens segments.

Cependant, on ne doit pas croire que la région où se manifeste la formation de la tête de stolon s'avance outre mesure, et il est sûr qu'il y a une certaine limite, bien que je ne puisse pas préciser d'une façon certaine jusqu'à quelle région du corps est répartie la faculté de cette formation. Quand nous avons enlevé à un même individu six segments d'une région relativement antérieure (: région plus reculée de quelques segments que le proventricule) et autant de segments de la région centrale du corps et comparé les états de régénération et de changement ultérieur de ces deux tronçons, chacun d'eux formait une tête en avant et six ou sept segments y compris un pygidium en arrière, au cours d'environ deux semaines après l'amputation c.-à-d. du 22 août au 7 sept. 1927. Et dans le tronçon enlevé de la région antérieure du corps, aucune tête de stolon n'apparaissait ni sur les nouveaux segments ni sur les anciens, tandis

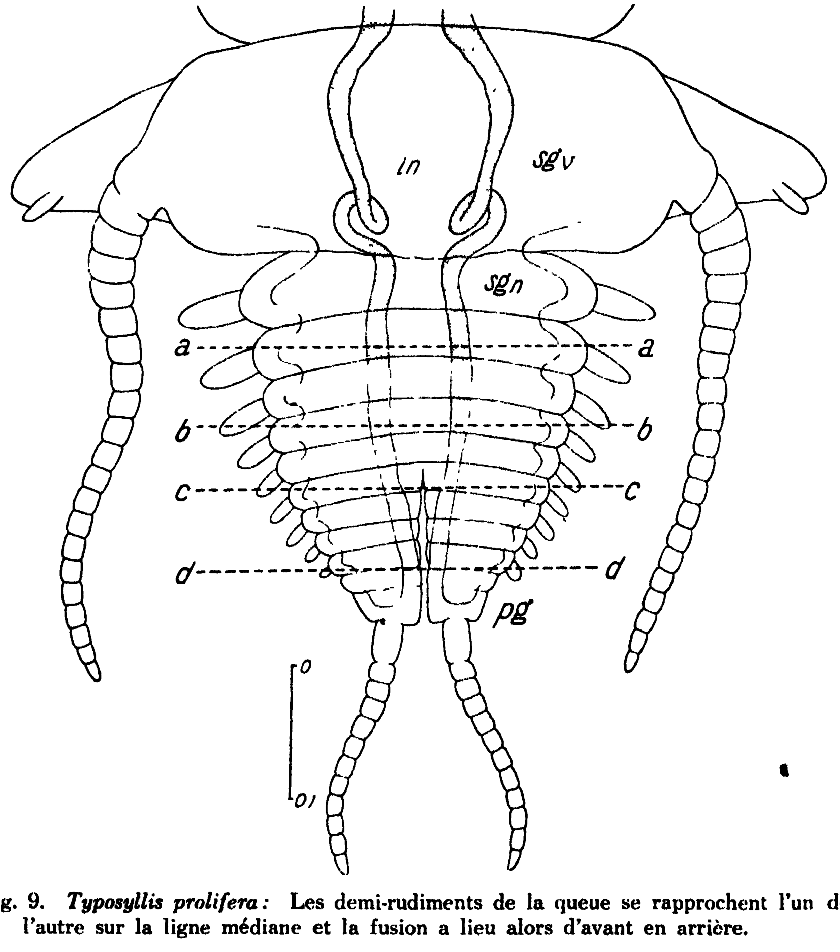

Fig. 9. *Typosyllis prolifera:* Les demi-rudiments de la queue se rapprochent l'un de l'autre sur la ligne médiane et la fusion a lieu alors d'avant en arrière.

que dans l'autre détaché de la région centrale la tête se formait entre les nouveaux et anciens segments. Nous pouvons en déduire que le niveau où se forme la tête de stolon est très variable mais qu'il est presque localisé dans la région centrale du corps.

De plus, et c'est le phénomène le plus étonnant dans la stolonisation de la *Typosyllis prolifera* que la formation de tête du stolon n'est pas toujours limitée dans un seul endroit et elle est parfois réalisée simultanément et aussi en chîne dans deux, trois ou même plusieurs segments. Dans un cas de stolonisation pluricéphalique rapporté dans le travail précédent (Okada 1934), le ver ayant 20 mm. de taille et 60 segments environ, manifestait une formation de tête en chaîne sur les quatre segments successifs 45, 46, 47 et 48. Michel (1909) a rapporté un cas de *Typosyllis amica* où un fragment médian composé d'environ 38 segments formait, au moment de sa régénération, une chaîne de douze têtes de stolon du 2e au 13e segment; mais il n'a rien dit de la régénération postérieure. D'après mes observations sur la *Typosyllis prolifera*, la régénération caudale est aussi entraînée en même temps, par conséquent les segments inter-

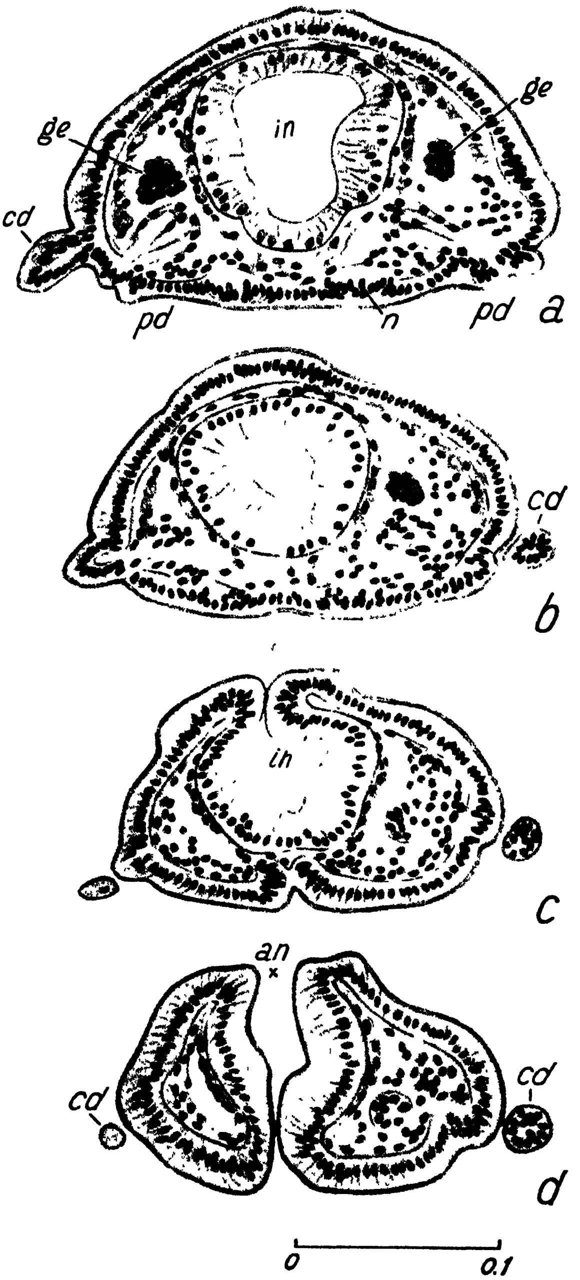

Fig. 10. *Typosyllis prolifera:* séries de sections transversales à différents niveaux de la nouvelle queue issue des deux demi-rudiments de la figure précédente; *a* et *b* se trouvent à deux niveaux où la fusion des demi-rudiments est complète. *c*, deux rudiments se sont juste rapprochés l'un de l'autre sur la ligne médiane, mais la fusion est encore incomplète. *d*, deux rudiments restent encore séparés l'un de l'autre.

médiaires forment chacun une tête en avant et une queue à l'extrémité postérieure. La régénération caudale d'un segment est entraînée par formation de la tête à l'extrémité antérieure du segment qui le suit, d'ailleurs il semble qu'elle le soit surtout après que la tête a pris un certain développement. En outre, cette formation inductrice se produit indépendamment à droite et à gauche, par conséquent lorsque la formation de tête est limitée à un seul côté du segment, un demi-bourgeon de queue du segment qui le précède ne se forme également que de ce même côté, son partenaire n'apparaissant pas de l'autre.

Quoi qu'il en soit, le phénomène de la formation pluricéphalique chez les *Typosyllis prolifera* et *Typosyllis amica* paraît être à l'origine de la formation des stolons en file chez la *Trypanosyllis asterobia* que nous décrirons plus loin.

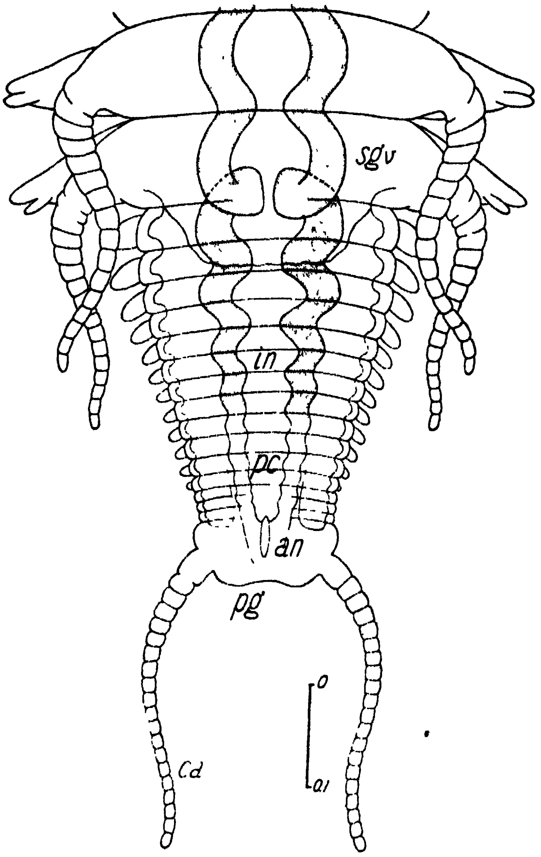

Fig. 11. *Typosyllis prolifera :* La formation de la queue médiane est maintenant complète après détachement du stolon et elle ne demande qu'à s'allonger davantage par l'addition de plus de segments. Dans les figures 4, 7, 8, 9 et 11, la partie endodermique du canal alimentaire est représentée par l'area pointillée.

Chez la *Trypanosyllis zebra*, la régénération du corps postérieur de la stolonisation c.-à-d. la tête du stolon est un peu moins développée que chez la *Typosyllis prolifera*, mais celle de la souche en arrière, beaucoup plus avancée, forme déjà, avant l'indication de la tête, une paire de bourrelets sur la face ventrale de son dernier segment (fig. 13 a), et lorsque la tête du stolon s'aperçoit à peine, ces bourrelets forment déjà une queue médiane petite mais parafaite en s'unissant à la face ventro-médiane du segment (fig. 13 b). Par conséquent, quand le stolon arrive à sa pleine maturité et se sépare, le régénérateur postérieur de la souche présente un allongement assez intense sous l'aspect d'une deuxième queue bifurquée vers le côté inférieur (fig. 13 c). Marion et Bobretsky (1875, p. 36), qui les premiers ont découvert cette formation de queue extraordinaire, l'expliquèrent ainsi : « Les demi-bourgeons

Tableau II

Tableau synoptique de la stolonisation chez la *Typosyllis prolifera*.

Numéro des spécimens		1	2	3	4	5	6	7	8	9	10
Sexe		♀	♀	♀	♀	♂	♂	♂	♂	?	?
Limite antérieure des segments génitaux		33 me	33 me	34 me	35 me	36 me	39 me	46 me			
Nombre de segments génitaux dans la souche	6					• •	• •	• •			
	5					• •	• •	• •			
	4					• •	• •	• •			
	3	•	•	•	•	• •	• •	• •			
	2	• •	• •	• •	• •	• •	• •	• •			
	1	• •	• •	• •	• •	• •	• •	• •	?	?	?
Niveau de séparation; Entre les segments		35-36	35-36	36-37	38-39	41-42	45-46	51-52	58-59	35-36	42-43
Nombre de segments dans le stolon		18	19	25	17	21	18	17	10+R	R	R

• ou • • signifie la localisation des éléments sexuels en avant du niveau de division.

s'allongent; viennent ensemble, se réunissent le long de leurs bords intérieurs, et se fondent dorsalement et ventralement, de façon à former une structure tubaire avec une cavité cylindrique. Cette cavité communique avec l'intestin de la souche et devient le canal alimentaire de la nouvelle queue qui paraît ainsi être formée d'ectoderme ». En ce qui concerne la formation du canal alimentaire, comme nous l'avons décrit dans le passage sur la *Typosyllis prolifera*, la couche ectodermique formant la face intérieure des demi-bourgeons est repoussée peu à peu en arrière par la couche endodermique de l'intestin qui y pénètre de la souche en même temps que se produit l'allongement de la nouvelle queue fusionnée; en fin de compte, la couche ectodermique ne forme qu'une partie, postérieure, du canal c.-à-d. le proctoderme. Le canal alimentaire de la nouvelle queue est donc formé en grande partie d'un prolongement intestinal de la souche. Ce phénomène nous donne une base

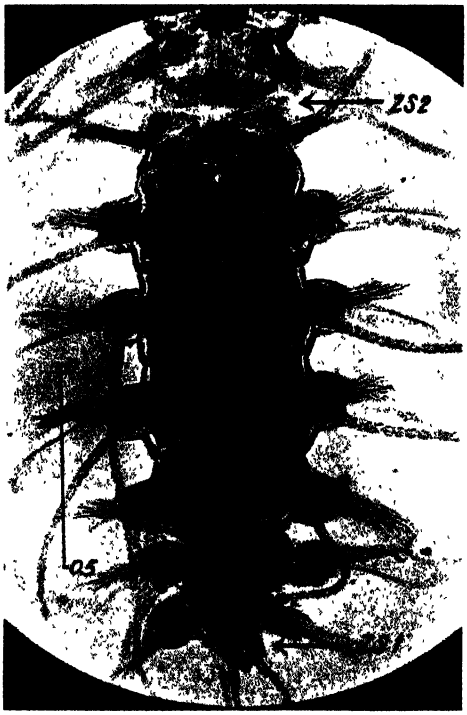

Fig. 12. *Typosyllis prolifera:* La stolonisation précède la régénération postérieure après détachement du stolon précédent: le nouveau stolon consiste en anciens segments seuls. *zs1*, le niveau où le stolon précédent a été séparé; *zs2*, le niveau où le présent stolon se sépare.

fondamentale pour expliquer pourquoi les stolons perdent l'élément intestinal dans leur développement en file chez la *Trypanosyllis asterobia* que nous allons décrire ci-dessous et aussi dans le bourgeonnement dit collatéral chez les autres *Trypanosyllis* gemmipares.

Ce qui est le plus caractéristique de la stolonisation chez la *Trypanosyllis asterobia*, c'est que la régénération de la souche manifestée avant la séparation du stolon en forme de très bonne heure non seulement un second mais encore parfois quelques dizaines à la fois (cf. Okada 1933 a, fig. 4, p. 329 et figs. 1–4 sur la pl. XII). En comparant cette espèce à la *Trypanosyllis gemmipara* de Johnson et à d'autres espèces voisines au même mode de reproduction connu sous le nom de bourgeonnement collatéral, on constate que chez la *Trypanosyllis asterobia* chaque stolon est formé sur chaque segment et que le niveau de son apparition s'avance d'un segment suivant l'ordre ; par suite les segments correspondants au nombre des stolons contribuent à la formation des stolons, en avant de la région où s'est formé le premier. On peut considérer ce phénomène comme cas de régénération caudale du stolon achevée dans la

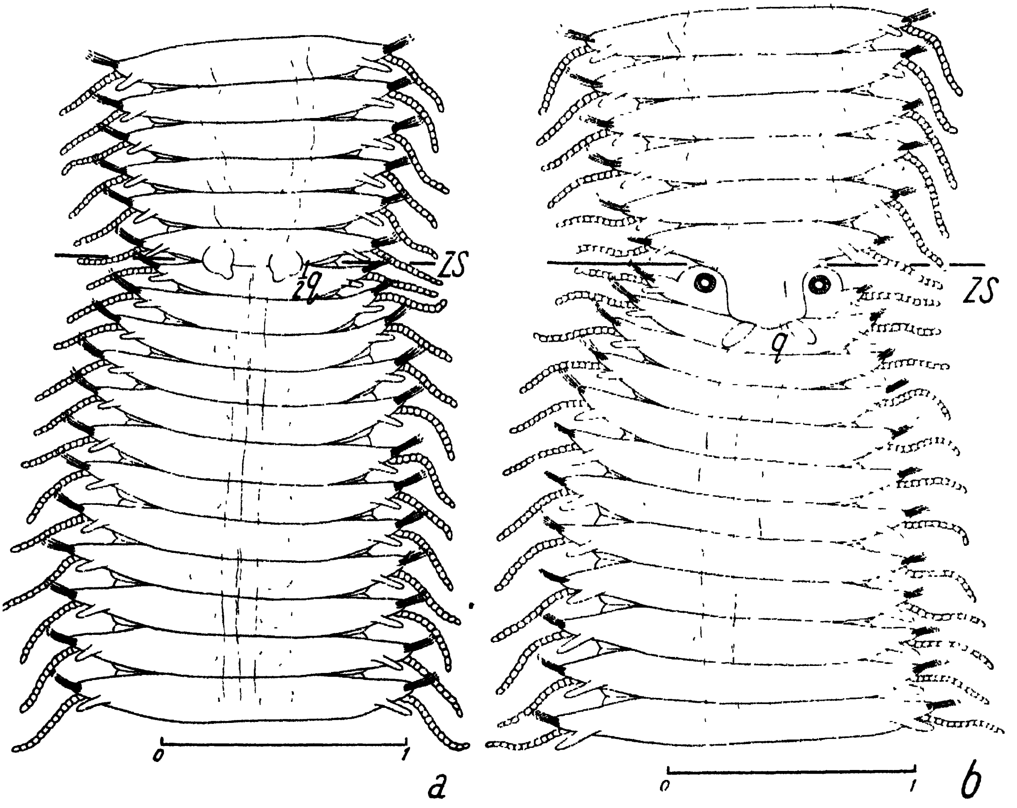

Fig. 13. Formation de la queue médiane chez la *Trypanosyllis zebra* avant détachement du stolon; *a*, la queue est représentée par une paire de demi-rudiments ($\frac{1}{2}q$) qui en *b* se rapprochent l'un de l'autre sur la ligne médiane et la fusion a lieu (q).

stolonisation pluricéphalique de la *Typosyllis prolifera* précitée. La formation du stolon chez la *Trypanosyllis* en question est une régénération indépendante produite sur chaque segment dans un espace étendu à la région de prolifération. Dans ce cas, l'ancien segment est donc toujours recueilli dans la constitution du stolon et forme ainsi le premier segment sétigère (fig. 15).

Chacun de ces stolons, comme nous venons de le dire, achève très rapidement son développement, et on ne trouve presque pas de différence surtout entre quelques individus précédents et suivants ; cependant logiquement et en fait, les individus qui se trouvent en avant ont toujours un développement un peu plus retardé que ceux qui les suivent et ils sont donc plus jeunes. Cette distinction est surtout très nette en comparant deux individus assez éloignés l'un de l'autre (cf. Okada 1933 a fig. 4). Dans quelques segments voisins de la limite antérieure de la région de stolonisation, le stolon se montre comme une protubérance non-segmentée à la face ventro-médiane du corps souche, et dans d'autres plus en avant, il n'est qu'une paire de demi-bourgeons ne se soudant pas encore par le milieu (fig. 14). Le développement de cette protubérance ou de ces demi-bourgeons en un stolon n'est alars que le changement évolutif d'une queue chez la *Trypanosyllis zebra*, changement qui est représenté ici d'avant en arrière dans de différents segments (comparer les figs. 13 a- d et 14).

Cependant, chez la *Trypanosyllis zebra*, la queue régénérée est unique et il lui faut beaucoup de temps pour s'achever ; par conséquent le canal intestinal de la souche a assez de temps pour s'allonger dans cette nouvelle formation; par contre, chez la *Trypanosyllis asterobia* il produit très rapidement un grand nombre de queues à la fois et encore dans un espace limité, ne lui donnant pas le temps de la pénétrer. Il s'ensuit que sauf quelques premiers individus

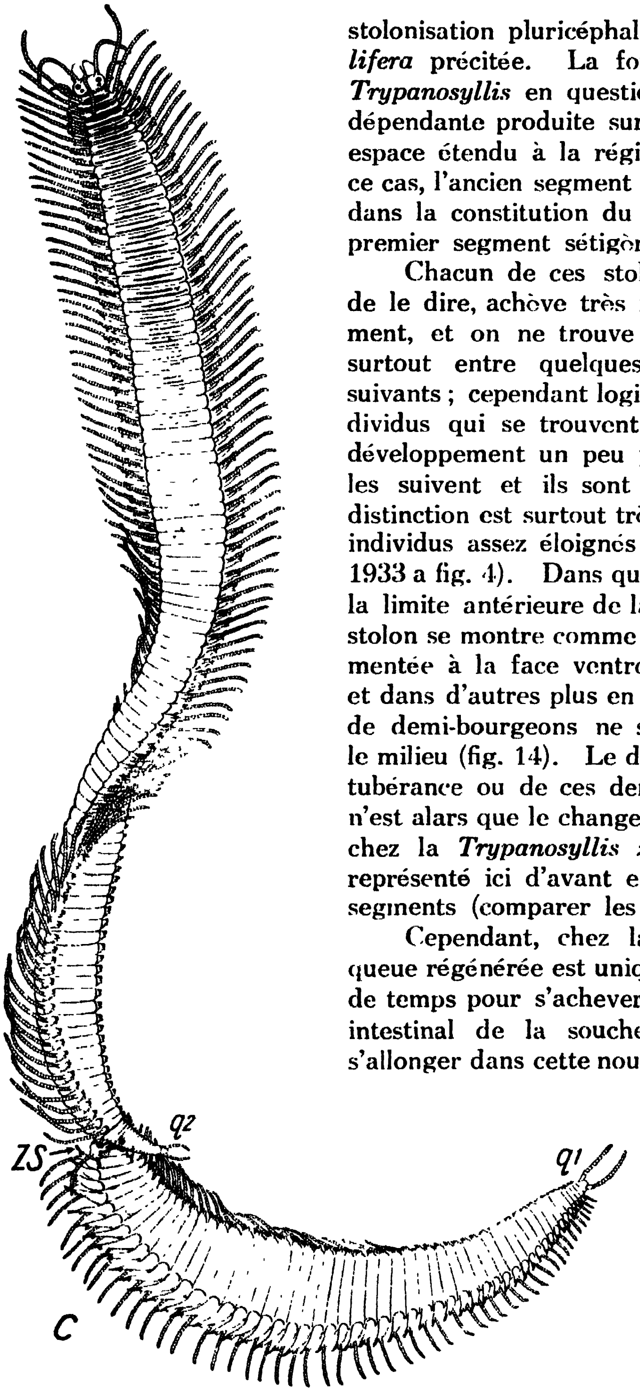

Fig. 13 c. Formation de la queue médiane chez la *Trypanosyllis zebra* avant détachement du stolon; la nouvelle queue (q_2) atteint une certaine longueur et l'animal paraît avoir à la fois deux queues, une longue et une courte.

qui ont fait leur développement en un temps relativement long (figs. 16a et 17a), les autres, formés après eux, achèvent le leur sans intestin (figs. 16b et 17b). Or, comme il a été dit plus haut, le premier segment sétigère du stolon étant

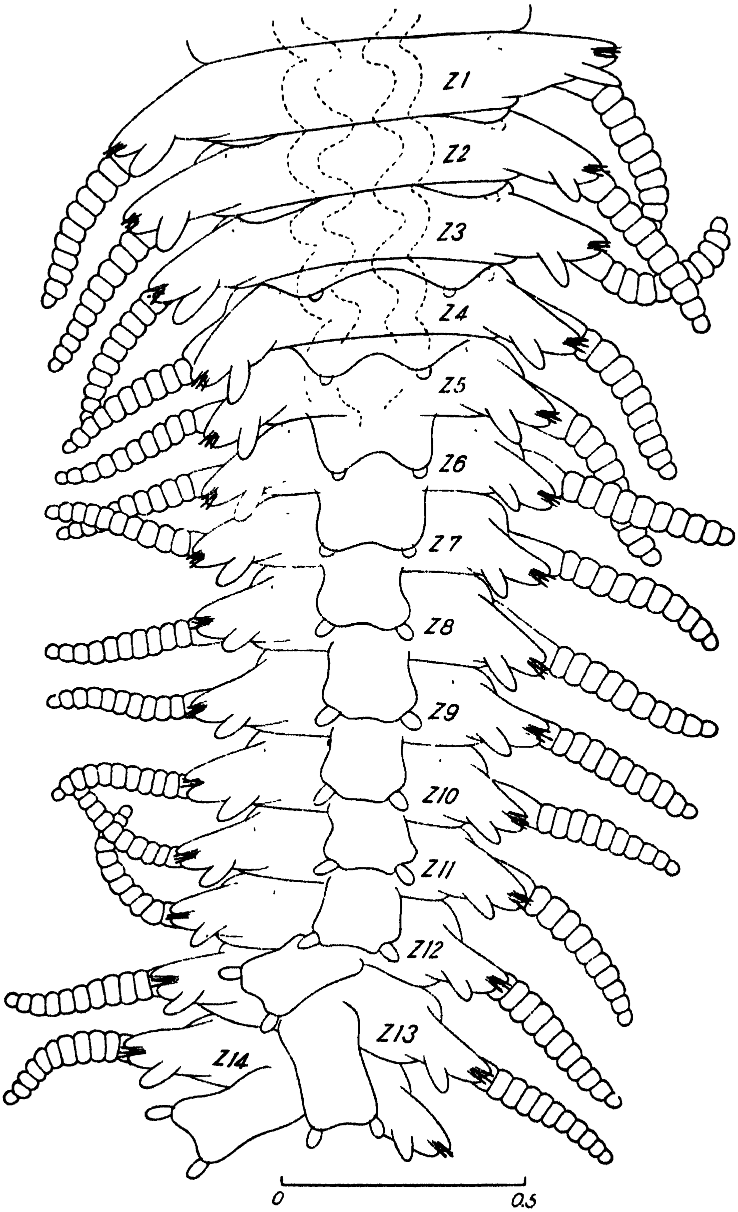

Fig. 14. Première partie de la file des stolons chez la *Trypanosyllis asterobia*, le mode de stolonisation étant représenté par les stolons à différents stades de développement et rangés en séries d'avant en arrière

celui de la souche, contient une partie de l'ancien canal alimentaire, mais le développement rapide et la séparation successive des stolons ne permettraient pas au canal laissé à ce seul segment de se développer dans un autre nouvellement formé ; ou bien, le canal ayant une taille trop courte serait privé du pouvoir de se prolonger suffisamment.

Le stolon détaché, d'après la forme du genre *Trypanosyllis* en général, est un type *Tétraglène* ayant une paire de gros yeux, mais par rapport à la *Trypanosyllis zebra*, l'extrémité antérieure de sa tête s'allogeant de deux côtés forme les tentacules latéraux (fig. 15). Il n'y a pourtant chez cette espèce aucune apparition des cirres tentaculaires qu'on remarque sur la tête du stolon de la *Trypanosyllis crosslandi* Potts, et au moment de sa séparation les soies natatoires sont très courtes ou souvent même invisibles. Le stolon a généralement une longueur de 10 mm. et possède presque toujours 12 segments sétigères et un pygidium (cf. Okada 1933 a, fig. 5, p. 330).

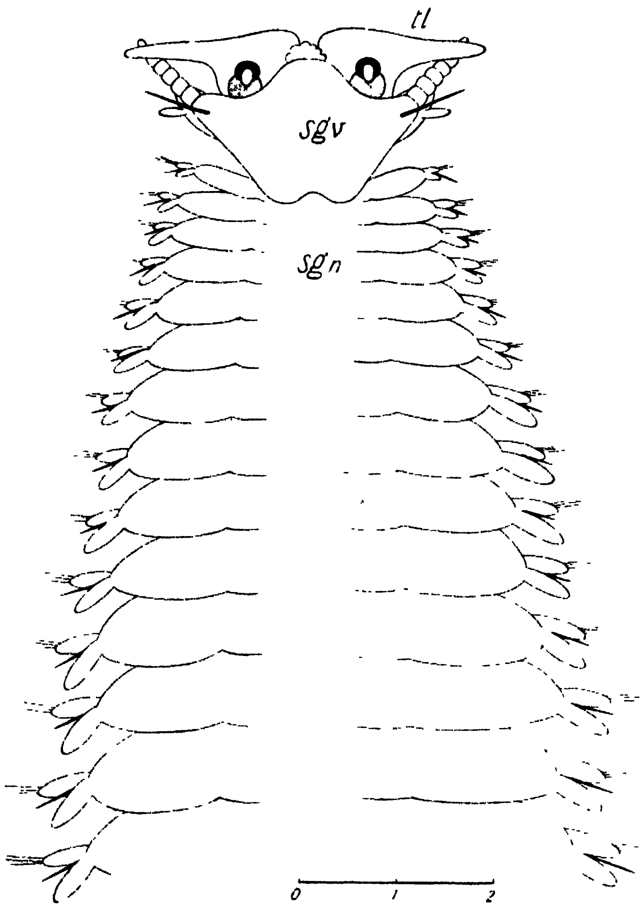

Fig. 15. Partie antérieure d'un stolon de *Trypanosyllis asterobia*, dont le premier segment sétigère est une inhérence de la souche-mère

Enfin, il est naturel que la formation des stolons chez la *Trypanosyllis asterobia* se fasse d'arrière en avant suivant un ordre fixe, mais son degré d'avancement étant presque insignifiant, elle paraît plutôt simultanée ou catastrophique. Comme il est remarqué dans la figure 2 sur la planche (Pl. XXIII) il y a une grande différence de stade entre les stolons en groupe produits par la première catastrophe et ceux formés par la seconde.

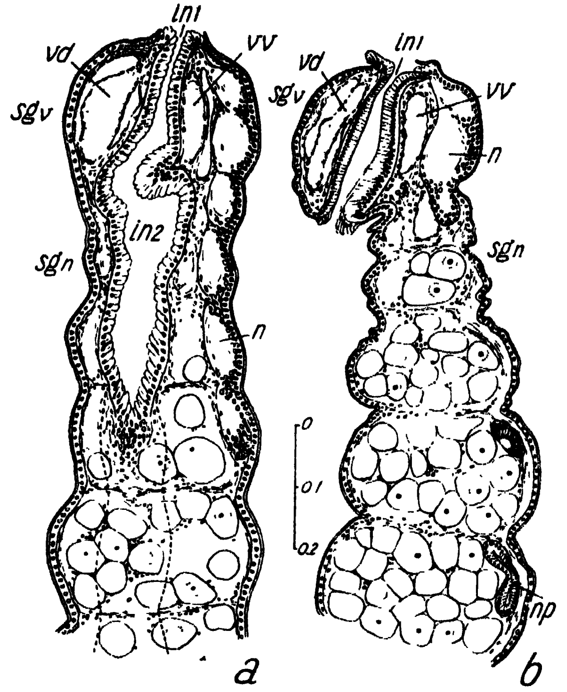

Fig. 16. *Trypanosyllis asterobia:* Sections longitudinales de deux types de stolon, dont *a* possède l'intestin et *b* n'en a pas. *in1*, intestin d'un ancien segment doté de la souche; *in2*, intestin développé dans les nouveaux segments du stolon.

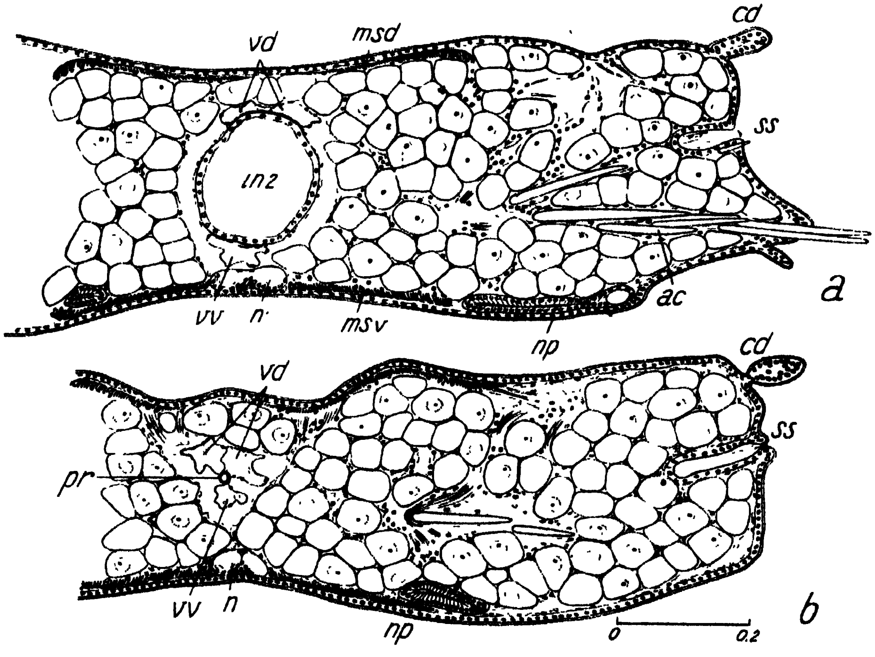

Fig. 17. *Trypanosyllis asterobia:* Sections transversales de deux types de stolon, comme il est montré dans la figure précédente, dont *a* possède l'intestin et *b* n'en a pas. *msd*, muscles longitudinaux du côté dorsal; *msv*, muscles longitudinaux du côté ventral; *pr*, péritoine en forme de tube; *ss*, base des soies natatoires.

Stolonisation gemmipare chez les *Trypanosyllis*

On soutiendrait volontiers que la file des stolons chez la *Trypanosyllis asterobia* provient d'une formation pluricéphalique qui se fait voir parfois chez la *Typosyllis prolifera* ou chez d'autres espèces voisines. Les autres *Tryoanosyllis* gemipares traînent aussi une rosette ou un faisceau de stolons formé à l'extrémité postérieure, mais il faut considérer ces deux cas comme tout à fait différents au point de vue de leur origine et du mode de développement des stolons. Le terme de « bourgeonnement collatéral » employé par Johnson (1901) pour ce type de stolonisation indique en effet un mode de formation des stolons, mais quant à sa signification, il faudrait y faire une objection. Le zoonïte formateur des stolons chez la *Tryponosyllis gemmipara* examinée par lui ayant été bien dévié vers la face latérale du segment de la région de prolifération, il a donné la dite désignation à cette formation des stolons en l'assimilant au bourgeonnement latéral chez la *Syllis ramosa ;* or, d'après la révision postérieure de Potts (1913) faite sur de nombreux cas, le zoonïte formateur en question se trouve généralement à la face ventro-médiane du segment de la région prolifératrice, et c'est plutôt dans un cas exceptionnel qu'il dévie vers un seul côté comme Johnson l'a dit. Il serait donc raisonnable de croire que cette déviation est dûe à de nombreux stolons formés à la fois dans un espace très limité c.-à-d. dans un ou deux des derniers segments de la souche. Potts (l. c., p. 440) désigne la formation des stolons dans ce cas sous le nom de « bourgeonnement ventro-terminal », mais en tenant compte de la rangée des stolons produits, il conserve le terme de Johnson et cependant, dans la signification, il le distingue nettement du bourgeonnement latéral chez la *Syllis ramosa.*

Sans parler de la convenance ou non de cette terminologie, on peut énumérer les espèces suivantes comme prenant ce mode de prolifération : *Trypanosyllis gemmipara* de Johnson, précitée, *Trypanosyllis ingeus* (Johnson 1902), *Trypanosyllis misakiensis* (Izuka 1906) et *Trypanosyllis crosslandi,* décrite par Potts (1911). Ces quatre espèces sont plus ou moins différentes les unes des autres par leurs caractères spécifiques, mais il est dit qu'au moment de leur stolonisation un grand nombre de stolons apparaît toujours en groupe à la face ventrale d'un ou deux des derniers segments de la souche et que leur nombre atteint même plus de 50 (Johnson 1902, p. 303). Au cas où les stolons sont peu nombreux, ils diminuent nettement de grandeur d'arrière en avant et leur rangée n'est pas si irrégulière ; cependant, en raison du fait que l'espace de leur apparition est bien limité, les individus antérieurs et postérieurs ne s'entassent jamais sur la même face et s'entre-croisent à droite et à gauche en profitant du plus petit espace. On remarque aussi ce phénomène chez la *Trypanosyllis asterobia.* Quand de nombreux stolons se produisent à la fois, l'ordre de leur apparition n'est pas toujours d'accord avec l'axe antéro-postérieur du segment-souche et dessine tantôt une ligne oblique, tantôt une courbe semi-lunaire ; dans des cas extraordinaires, les stolons présentent une rangée spirale, mais alors cet ordre est conservé quand même et ceux qui se trouvent dans une position antérieure (: supérieure) ont toujours un développement plus tardif que ceux qui occupent une position postérieure (: inférieure).

Des faits ci-dessus observés on peut déduire ce qui suit: la formation d'une rosette ou d'un faisceau de stolons par prolifération gemmipare chez ces espèces de *Trypanosyllis* peut être considérée comme répétition successive de la stolonisation simple chez le type primitif *Trypanosyllis zebra* où la queue produite de très bonne heure par la souche forme le deuxième stolon avant séparation du premier. Et, en tant que l'avancement du niveau de stolonisation qu'on constate chez la *Trypanosyllis asterobia* est impossible dans ce cas, il est tout naturel que de nombreux stolons soient groupés à la même place et qu'un zoonïte formateur y soit établi pour contribuer à la formation des nouveaux individus; il paraît donc qu'il n'y a plus besoin de recourir aux anciens tissus pour la formation des stolons. L'alimentation par la souche est naturellement nécessaire à leur accroissement, tandis que la pénétration du canal intestinal y paraît moins indispensable. Reste la question de savoir dans quel état se trouvent les segments en arrière de la région de bourgeonnement, au moment de la formation du premier stolon. D'après Johnson (1902 p. 306), « ils resemblent beaucoup, comme aspect général, à ceux des bourgeons, et sont remplis des éléments sexuels qui font défaut à tous les segments de la souche situés en avant au niveau de stolonisation, mais ils en diffèrent par la possession d'un canal alimentaire bien cilié et d'un anus et par l'absence de céphalisation ». Par rapport à cet état de chose, deux questions s'imposent: la partie postérieure remplie d'éléments sexuels reste-t-elle jusqu'à la fin sans se diviser, ou devient-elle un stolon complet en formant tardivement la tête? Lorsqu'on admet la première hypothèse, il paraît que chez cette espèce de *Trypanosyllis*, la formation des stolons prend uniquement le mode gemmipare, car la zone de prolifération est déterminée dès le début de la stolonisation. Or, d'après la description de Potts (1913), chez tous les spécimens de *Trypanosyllis crosslandi* la stolonisation se manifestait toujours à l'extrémité postérieure de la souche et il leur manquait la partie postérieure comparable à l'appendice génital de *Trypanosyllis gemmipara*. Par conséquent, quoique, chez cette espèce de Potts au moins, la partie postérieure ne constitue pas un stolon complet, il paraît qu'elle se sépare de la souche au cours du phénomène de bourgeonnement. D'autre part, Izuka (1906, p. 287) dit: « Chez la *Trypanosyllis misakiensis* le canal alimentaire du stolon est la continuation directe de celui du corps souche; il est mince et se termine en anus du segment anal ». Autant que ses observations sont justes, il est probable que la partie postérieure du corps de l'ancien ver forme aussi un individu indépendant en procédant à la céphalisation.

En somme, soit que les segments suivant la région de prolifération se détachent de la souche, soit qu'ils ne s'en détachent pas, la stolonisation des *Trypanosyllis* se produit toujours à une distance fixe (: la longueur d'un stolon) de l'extrémité caudale, c.-à-d. à la face ventro-médiane du dernier segment de la souche; bien entendu c'est parce que la régénération de la partie postérieure plus en arrière est répétée rapidement et maintes fois. En cas de prolifération particulièrement rapide, les stolons produits près du zoonïte formateur se mettent plutôt en rangées transversales, et tous les individus du même rang se trouvent en même état de développement. On peut en supposer deux causes pour ceux du même rang : soit qu'ils se forment par division transversale d'un bourgeon, ou que les individus qui s'accroissent innombrablement en avant et en arrière, étant forcés de se ranger dans un espace très limité comme nous l'avons dit plus haut, produisent secondairement quelques rangées transversales en se fléchissant en zigzag, cependant que ceux du même rang, apparaissant presque en même temps, effectuent ainsi le même développement.

D'après mes observations expérimentales sur la *Typosyllis prolifera*, un demi-bourgeon de queue qui a perdu son partenaire ne forme jamais une queue complète (Okada 1934). En tenant compte de ce fait, il semble que la division du bourgeon soit impossible aussi dans ce cas. D'autre part, quant aux rangées centralisées ou spirales, Potts donne l'explication suivante : « Les stolons augmentant de longueur et de largeur, ceux qui se trouvent en dehors du rang sont expulsés vers le côté et le devant, à cause de la présence des rangs en arrière, de telle sorte que le rang prend la forme d'un croissant, et que la région de prolifération est en partie entourée de stolons en voie de développement. L'irrégularité doît se produire pourtant fréquemment par l'inégalité de croissance » (1913 p. 416). Enfin, les rapports entre le mode de prolifération par gemmiparité chez les *Trypanosyllis* précitées et celui par bourgeonnement latéral chez la *Syllis ramosa* seront mis en évidence en décrivant le bourgeonnement et la stolonisation de cette dernière espèce.

Stolonisation chez la *Syllis ramosa*

Le branchement étonnant du corps chez cet animal, signalé pour la première fois par McIntosh (1885), est toujours cité comme un cas extrême de mode de bourgeonnement chez les Annélides. D'après mes observations, ce branchement n'a aucun rapport de causalité directe avec la formation du stolon dont nous nous occupons ici maintenant et il doit être considéré, de sa nature, comme un phénomène tératologique. Si l'on veut en chercher une comparaison chez d'autres animaux, ce branchement serait équivalent à celui du bras de certaines Ophiurides. Une seule différence entre ces deux cas est qu'en cas de Syllide chaque branche a le pouvoir de former un individu c.-à-d. un stolon.

L'état où le stolon s'attache à une branche est décrit par McIntosh comme suit : — « Un pédicule de quatre segments étroits est intervenu entre la tête du stolon et le point d'attache de celui-ci au corps-mère ». Et sur les trois premiers segments du pédicule on ne voit ni tentacules ni parapodes, mais il est certain qu'ils sont indépendants les uns des autres quand on observe d'autres structures (cf. sa fig. 11, pl. 33). A ma connaissance, cet animal vit en parasite dans une éponge siliceuse, la *Crateromorpha meyeri*, qu'on trouve dans la profondeur de la mer de Sagami et manifeste sa stolonisation en été. Dans la stolonisation, les individus ne prennent pas naissance successivement les uns aux autres dans un même endroit, comme le cas des *Trypanosyllis* gemmipares, mais ils se forment à la fois en grand nombre sur les branches, à raison d'un stolon par branche. Par conséquent, il est douteux qu'il existe entre le stolon et la branche, comme il a été décrit par McIntosh, un pédicule composé des segments peu nombreux et incomplets n'ayant ni tentacules ni parapodes. Le nombre des segments existant entre le point de branchement et le stolon n'est pas toujours constant, et on peut dire qu'une tête de stolon apparaît au delà du nombre des segments qui sont suffisants pour former toute la longueur du stolon à partir de l'extrémité postérieure de chaque branche. Quand on regarde donc à part chacune de ces branches, la stolonisation de la *Syllis ramosa* n'est autre qu'une simple schizogamie. D'autre part, en comparant ce pédicule observé par Mc Intosh avec le pédicule non-segmenté apparu entre le stolon et la souche de la *Trypanosyllis gemmipara* (cf. Johnston 1902, p. 314), on constate qu'il n'existe entre eux aucun rapport de structure et d'origine. Quant au degré de développement de la tête du stolon, ce n'est qu'un type *Tétraglène* dépourvu d'appendices, sauf l'apparition d'une paire d'yeux bien développés, comme l'a observé McIntosh. Le stolon femelle remplit presque tous les segments d'oeufs; chaque segment en est enflé. Le mâle a le même développement de la tête que la femelle, mais la différenciation de ses segments sétigères s'avance d'un pas plus que l'autre: on y observe une métamorphose remarquable des parapodes en nageoires et le développement de soies natatoires bien prolongées. La production des spermatozoïdes est limitée aux huit premiers segments et les éléments sexuels font défaut aux autres postérieurs (fig. 2, pl. XXIII.). Une telle différenciation des segments sétigères du stolon n'est jamais remarquée chez aucune autre espèce de la sous-famille Syllinae. A ce point de vue, le stolon mâle de la *Syllis ramosa* présente une structure plus avancée que les autres Syllidés en général. Chez les spécimens d'origine de Misaki, le stolon mâle possède généralement une longueur de 6 mm. environ et est composé de 27 à 28 segments.

En examinant en détail le mode de branchement chez la *Syllis ramosa*, on en trouve deux cas: dans l'un le branchement est symétrique à droite et à gauche, et dans l'autre il est limité à un seul côté droit ou gauche. Dans l'un et l'autre cas, la source d'un beurgeon se trouve toujours au niveau parapodial et jamais entre deux segments. C'est Oka (1895) qui a donné des explications sur ce mode de branchement; d'après lui, le branchement est provoqué par deux modes tout différents: « bourgeonnement intercalaire » et « bourgeonnement régénérateur ». Les bourgeons qui suivent le premier sont symétriques pour la plupart et ils sont en rapport avec l'apparition d'un nouveau segment entre les deux anciens: à chaque côté du niveau où doivent se produire des parapodes et des cirres de ce nouveau segment, ils prennent naissunce, à leur place, comme de menus boutons. Lorsque ces bourgeons ont un même développement, ils forment deux branches symétriques à droite et à gauche, et lorsqu'ils ont un développement différent l'un de l'autre, les branches qu'ils produisent ne sont plus symétriques, mais inégales.

Dans le branchement par bourgeonnement régénérateur, le cirre dorsal dégénère dans un côté des segments par une cause inconnue, et, selon mes observations, une masse cellulaire saillante, un peu opaque et distincte fait son apparition à la place de ce cirre, au niveau correspondant à sa base (fig. 18 a, *br_1*). Et le nouveau cirre dorsal qui se reproduit à partir de cette masse à la prochaine occasion est un peu plus gros que l'ancien et a à son extrémité une paire de cirres anaux très minces (fig. 18 *br*$_2$). Les parapodes qui se trouvent au bas du bourgeon régénérateur dégénèrent peu à peu avec le développement de celui-ci et finissent par disparaître complètement. Dans la phase suivante de leur développement, observée sur de nombreux spécimens, tous les bourgeons régénérateurs s'allongeaient et se segmentaient; ils présentaient ainsi une forme suffisamment développée comme une branche indépendante et avaient un prolongement du canal alimentaire de la souche (fig. 18 c–d).

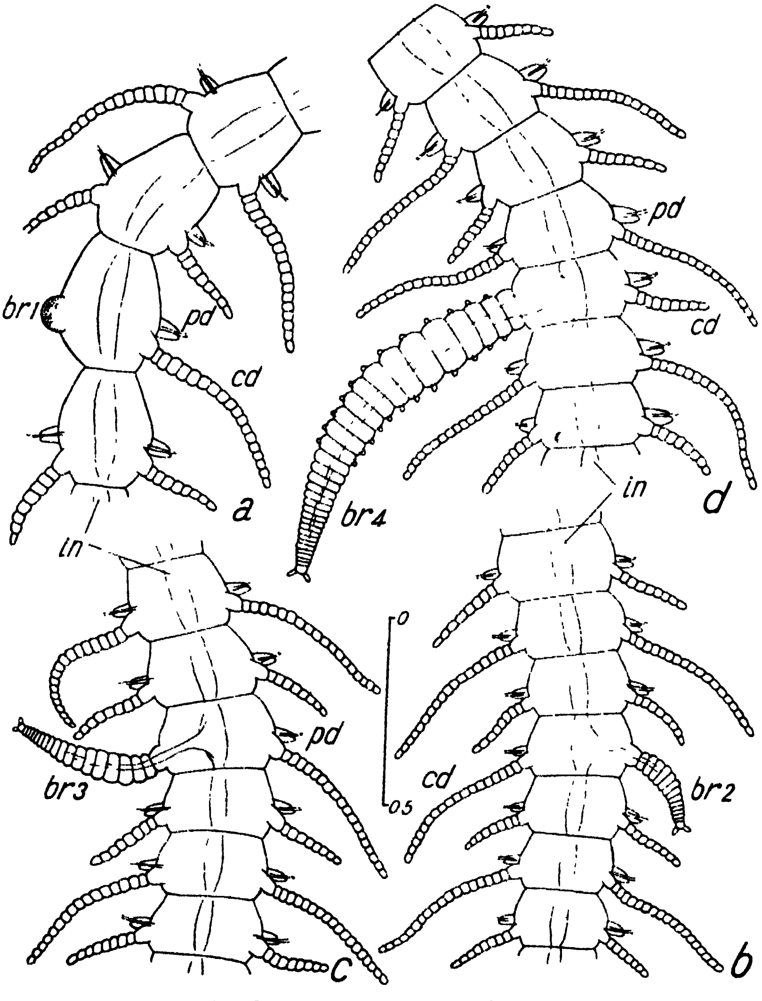

Fig. 18. Différents stades de bourgeonnement régénérateur chez la *Syllis ramosa*.

En somme, les deux modes de bourgeonnement en question ne diffèrent l'un de l'autre que par l'époque de la production des bourgeons, et dans les deux cas, le bourgeon peut être également considéré comme une transformation du cirre dorsal. Dans le bourgeonnement intercalaire, le parapode fait défaut dès le début, tandis que dans le bourgeonnement régénérateur, il est peu à peu absorbé et réduit à rien avec le prolongement du bourgeon régénérateur. Pourquoi le parapode ne se produit-il pas dans le premier cas? Chez les Polychètes, au moins chez les Syllidiens, la formation du parapode est toujours plus retardée que celle du cirre dorsal; par conséquent, il paraît que lorsque les bourgeons latéraux se produisent à la place des cirres dorsaux, le phénomène de dégénérescence des parapodes qui suit cette production est compris dans leur incapacité d'apparition.

En ce qui concerne la cause du bourgeonnement, Brunel et Schoener (1904) disent qu'elle provient d'une plaie occasionnée par une aiguille aiguë de l'éponge siliceuse où le ver vit en parasite. Mais alors, pourquoi deux modes de bourgeonnement sont-ils provoqués par un même traumatisme? Pourrait-on en attribuer la cause à l'importance de la plaie occasionnée et supposer, par exemple le bourgeonnement intercalaire dans le cas où elle atteint le canal alimentaire et le bourgeonnement régénérateur dans le cas où celle qui est donnée sur les parois du corps ne dépouille que le cirre dorsal? Le branchement latéral peut être provoqué par un traumatisme, comme Oka l'a constaté sur un spécimen montré dans sa figure 4: il a trouvé qu'une plaie donnée à la queue d'un bourgeon en développement entraînait la formation d'une paire de branches parallèles. Cependant, il n'est pas certain que la séparation des stolons ou l'amputation du corps provoquée par d'autres causes soient toujours le facteur du branchement. Il paraît que la régénération après séparation des stolons produit plutôt la queue pour la plupart des cas. Mais le niveau d'apparition des bourgeons régénérateurs, contrairement à nos expériences, se trouve dans ce cas à l'extrémité postérieure au-dessus du canal alimentaire. Ces bourgeons sont formés généralement au-dessous de celui qui est en contact avec le nerf. Ce fait semble lié à ce que le branchement a lieu à la base du cirre dorsal, et il est provoqué, au moins à son début, sans rapport direct avec la chaîne nerveuse ventrale.

B. Stolonisation chez les Autolytidés

Le mode de reproduction asexuée chez tous les genres de cette tribu est divisé en deux: stolonisation scissipare (schizogamie) et stolonisation gemmipare (gemmiparité). La première est le cas où une tête se produit à un niveau du corps et où les segments qui le suivent se séparent de la souche en devenant un ver indépendant; la seconde est le cas où non seulement la souche régénère de nouveaux segments avant que le premier stolon s'en détache, mais encore elle donne aussi d'autres stolons. Dans la première, la formation du stolon est unique, tandis que dans la seconde une chaîne de stolons est souvent formée. La formation des stolons en chaîne chez la *Myrianida pinnigera* était considérée, jusqu'à la publication de mon travail en 1934, comme gemmation terminale du dernier segment de la souche; c'est parce que chez cette espèce la schizogamie détachant un simple stolon ne se manifestait jamais et, que le stade lui correspondant étant très court, passait immédiatement au stade suivant. Cependant en principe, cette formation ne diffère nullement de celle des stolons en chaîne chez l'*Autolytus Edwarsi* et chez d'autres espèces voisines de forme gemmipare.

En comparant le mode de reproduction de cette espèce avec le bourgeonnement ventro-médian des *Trypanosyllis*, on constate qu'il existe entre eux l'analogie que la régénération postérieure est particulièrement rapide et répétée à plusieurs reprises par la souche avant séparation du premier stolon ; cependant, il y a une grande différence entre eux en ce qui concerne la région de prolifération des nouveaux segments et la direction de leur développement : l'un provoque un faisceau et l'autre une chaîne de stolons.

Chez les *Trypanosyllis*, le tissu régénérateur apparaît d'abord dans une région ventro-latérale d'un segment qui se trouve dans la partie postérieure du ver, ensuite il passe au niveau ventro-médian, établit là un zoonïte formateur de stolons ; les stolons formés viennent se ranger presque verticalement à la face ventrale de la souche. Alors, cette région destinée à former des stolons étant trop limitée en espace, une modification secondaire intervient dans leur arrangement, mais elle n'exerce aucune influence sur la communication directe entre les segments non-sexués en avant et les segments sexués en arrière. Par contre, chez les Autolytidés, la zone de prolifération, comme en cas de bourgeonnement intercalaire chez la *Syllis ramosa*, apparaît entre la souche et le premier stolon ; d'autres stolons produits par suite de sa prolifération linéale engendrent un prolongement intercalaire avec l'augmentation de nombre des stolons et l'accroissement de taille de chaque stolon, et ils forment parfois une longue chaîne d'individus. De plus, dans ce cas, le canal alimentaire de la souche traverse le milieu de tous les stolons et atteint l'anus qui se trouve dans le dernier segment du premier stolon situé à l'extrémité postérieure. Cela va sans dire que le corps du ver se prolonge d'autant plus que les nouveaux segments interviennent entre la souche et le premier stolon. En somme, la différence entre ces deux cas extrêmes de gemmiparité dépend uniquement de ce que le premier bourgeon régénérateur se produit à un niveau ventro-médian de la souche ou de ce qu'il se forme entre un segment et un autre.

En étudiant maintenant la schizogamie simple à production d'un seul stolon chez les Autolytidés, on en trouve deux catégories différentes : l'une est un précurseur de la formation d'une chaîne de stolons et l'autre n'a aucun rapport avec la formation de cette chaîne. Il est caractéristique de la première que la structure du stolon est relativement simple et que, le niveau de sa formation n'étant pas constant pour la plupart des cas, est situé relativement en arrière du corps. Chez l'*Autolytus inermis*, lorsque le stolon se détache, on ne voit encore aucune formation de nouveaux segments à la souche, mais on peut se rendre compte par sa constitution et par le niveau de sa séparation (entre les segments 26–27 ou 30–31) que c'est le même type que la schizogamie simple apparaissant comme précurseur d'une chaîne de stolons.

C'est un fait bien connu que chez l'*Autolytus Edwarsi* et chez d'autres espèces voisines il se produit souvent la schizogamie à simple stolon tout à

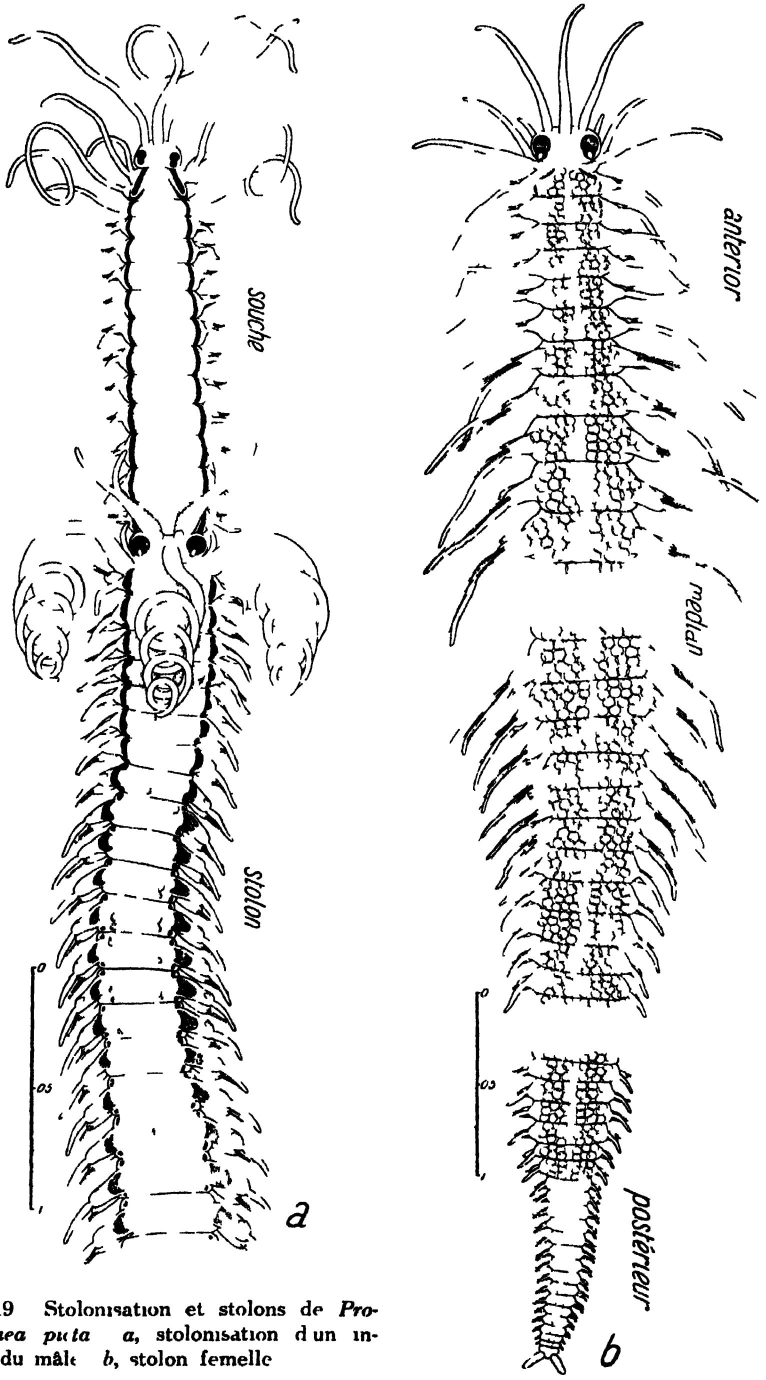

Fig 19 Stolonisation et stolons de *Proceraea picta* *a*, stolonisation d'un individu mâle *b*, stolon femelle

fait au début de la stolonisation. Dans ce cas-là, la région où apparaît la tête du stolon n'est pas toujours constante, mais l'est quelquefois seulement ; dans ce dernier cas, ce niveau se trouve toujours entre les segments 30 et 31 chez quelques espèces connues jusqu'ici, chez l'*Autolytus purpureimaculatus* par exemple (Okada 1933 a, p. 336). Quant à la position de la tête du stolon, j'y reviendrai au moment de parler du zoonïte formateur qui se produit dans la prolifération gemmipare.

La deuxième catégorie de schizogamie est caractérisée par le fait que la position où apparaît la seconde tête est toujours fixée à la face antéro-dorsale du 14e segment sétigère, et que, par rapport à cette formation antérieure, un changement de structure se manifeste évidemment dans ce segment et aussi dans les autres plus en arrière. Par exemple, une paire d'appendices plus développés et ornant la tête sexuée, est en général une paire de cirres tentaculaires dorsaux nouvellement formés, mais parfois, comme chez les *Procerastea* (fig. 21), une transformation directe des anciens cirres dorsaux qui garnissaient le premier segment sétigère du stolon. En plus, on voit se produire quelque modification aux cirres dorsaux du segment qui le suit. Ce qui est le plus remarquable, ce sont les stolons de *Proceraea longeferiens* connue sous le nom d'*Autolytus Alexandri* (cf. Okada 1929 a, figs. 30 et 31, p. 580). Et encore dans cette seconde catégorie des stolons, le corps est divisé nettement en trois parties antérieure, médiane et postérieure (figs. 19, 20, 21). La partie antérieure, sauf les cas particuliers (*Autolytus Alexandri* et *A. roseus*, cf. Okada 1933 b, p. 641), se compose généralement de 6 segments non-modifiés et remplis d'élément sexuels chez le stolon mâle. Les segments de la partie centrale en arrière du 7e sétigère subissent une transformation des parapodes en nageoires et se munissent de soies natatoires longues, quoiqu'il y ait assez de différence suivant les espèces et les sexes. Le nombre des segments qui se transforment n'est pas fixe dans cette partie. On ne voit pas de métamorphose de segments dans la partie postérieure. Parmi les espèces qui forment les stolons d'une différenciation si élevée et effectuent la séparation entre les segments 13 et 14, on peut compter, en dehors de la *Proceraea* établie par Ehlers, deux autres genres : *Procerastea* et *Virchowia*. Il y a encore une espèce qui produit, au point de vue de sa constitution, un stolon appartenant plutôt à la première catégorie, c'est la *Proceraea cornuta*. Cette dernière espèce vit habituellement sur les côtes orientales de l'Amérique du Nord, mais elle se trouve également depuis 1929 à Plymouth en Angleterre (Okada 1933 b, p. 645). Beaucoup plus petite que les autres du type *Proceraea* d'Ehlers, elle ne possède que 40 à 45 segments et rarement 50. A ce point de vue, cette espèce ressemble au type *Autolytus* de Grube ; de plus, la structure de tête du stolon et l'etat de métamorphose des segments ressemblent presque entièrement à ce dernier (cf. Okada l. c., fig. 3, p. 645). Cependant, la stolonisation étant toujours unique se manifeste entre les segments 13 et 14, et la partie antérieure non-modifiée du stolon se compose de six segments. C'est par là que cette espèce peut être classée dans la deuxième catégorie de schizogamie des Autolytidés. De plus, dans les stolons femelles les segments sétigères se divisent nettement en trois parties, antérieure, médiane et postérieure.

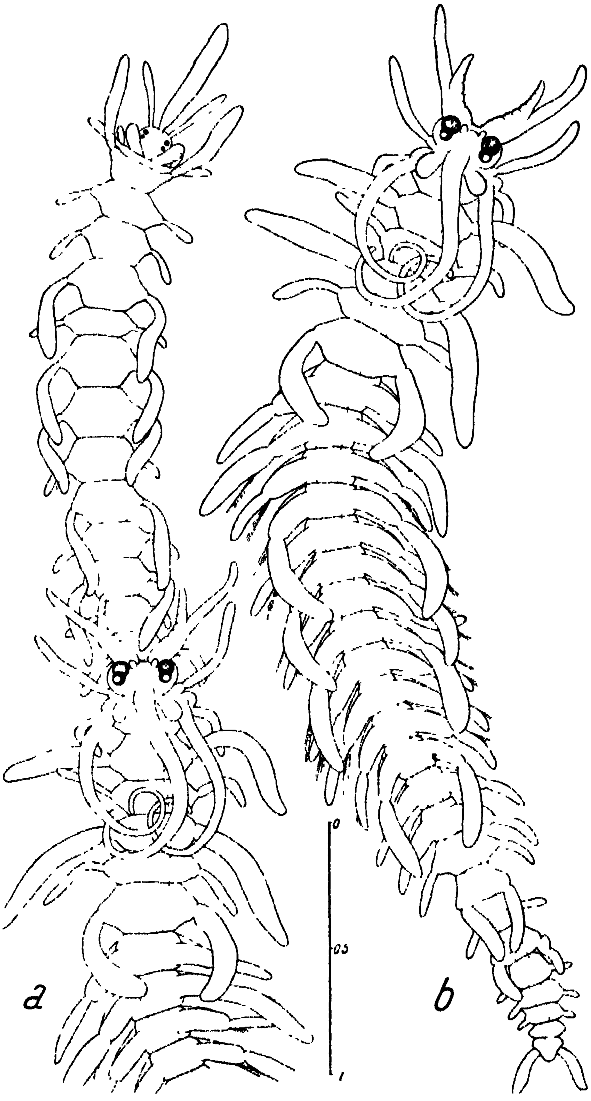

Fig. 20. *Virchowia clavata:* Stolonisation et stolon chez l'individu mâle.

La *Virchowia clavata* est aussi une petite espèce ne possédant qu'une tête, 40 segments sétigères et un pygidium, mais la stolonisation se produit toujours entre les segments 13 et 14; on observe sur le stolon d'abord 6 segments non-modifiés, ensuite environ 20 segments postérieurs manifestant la transformation des parapodes en nageoires, on remarque enfin que les suivants restent sans subir aucun changement et constituent la région postérieure non-modifiée (fig. 20). A ce point de vue, la formation du stolon est ici plus compliquée que celle de la forme précédente. D'autre part, chez cette espèce une paire d'appendices nucaux saillants est bien développée sur la tête et aussi sur celle du stolon nouvellement formé; cependant, les ornements latéraux de la tête du stolon ne sont qu'une paire de cirres tentaculaires dorsaux du segment nouvellement formé, comme dans le cas précédent et aucune influence de la céphalisation n'est remarquée sur les autres segments postérieurs.

Malaquin (1892, p. 321) écrit que chez la *Procerastea Halleziana* le prolongement du corps est entraîné par l'intercalation des nouveaux segments dans la région centrale avant la stolonisation, mais c'est une erreur due à l'insuffisance de ses observations; il a confondu avec la stolonisation le phénomène de régénération qui se manifeste après fragmentation du corps. Les phénomènes qui le suivent ont été bien mis en évidence par le travail d'Allen (1921). Quant au mode de stolonisation de cette espèce au moins, il ne diffère point de celui des Autolytidés du type *Proceraea* cité plus haut. Ce qui le caractérise est que dans tous les segments du corps, sauf la tête et le premier segment sétigère, les cirres dorsaux sont rudimentaires (ils n'apparaissent, des deux côtés des segments, que comme des mamelons peu saillants et relativement transparents), s'allongent plus ou moins au moment de la stolonisation et se développent en tentacules parfaits suivant les régions. C'est le 14e segment qui contribue directement à la céphalisation du stolon representant le premier segment sétigère de ce dernier et les autres segments postérieurs, excepté les 5 segments du 15e au 19e (voir fig. 21). Cependant, il est à remarquer que chez les mâles la métamorphose des parapodes est parfaite, tandis que le développement des cirres dorsaux sur ces segments modifiés de la partie centrale n'est pas si complet que chez les femelles (fig. 21 a). Il leur faudrait une nutrition considérable pour la transformation des parapodes en nageoires.

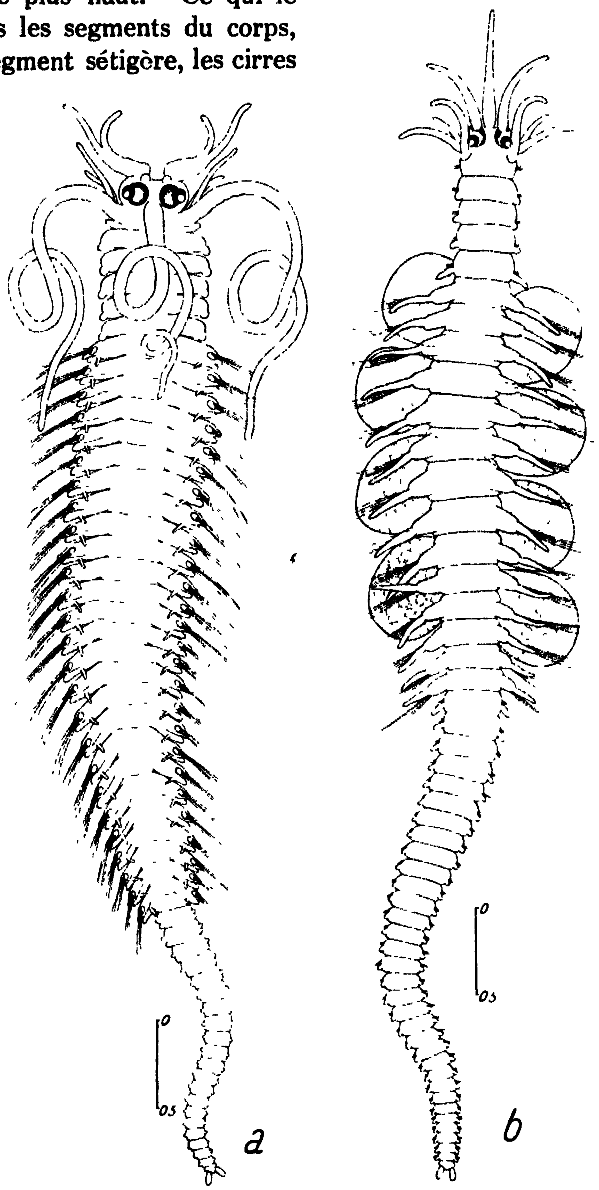

Fig. 21. Stolons mâle (*a*) et femelle (*b*) de *Procerastea Halleziana.*

Nous nous sommes bornés à observer ci-dessus certains cas de schizogamie chez les Autolytidés. Nous tenons à y ajouter pourtant quelques mots: lorsque la régénération à partir de la souche, qui se manifeste successivement par gemmation est retardée jusqu'au moment de la séparation du stolon, il est impossible d'établir une différence de mode et de structure, sauf concernant les caractères d'espèces, entre ce cas de régénération supprimée et le cas de vraie schizogamie. Pour cette raison, il est naturel que leur distinction n'ait pas été établie jusqu'ici, mais en les comparant en détail, on arrivera à une distinction que nous venons de faire: l'un n'a aucun rapport avec la gemmiparité et l'autre se trouve dans la position la plus primitive de la phase se développant selon la gemmiparité.

En amputant un spécimen d'*Autolytus Edwarsi* qui ne présente encore aucun signe de stolonisation de son extrémité antérieure, on peut provoquer facilement l'apparition d'une seconde tête dans un segment de la partie médiane du corps et y entraîner une schizogamie. Il va sans dire que le stolon formé se détache de la souche, mais ce détachement est généralement précédé de la formation d'une queue à l'extrémité postérieure de celle-ci (fig. 22 *pg*). La partie ainsi régénérée peut être comparée à la régénération postérieure chez les *Typosyllis prolifera* et *Trypanosyllis zebra*, bien qu'il y ait certaines différences de structure. Par contre, chez les *Proceraea*, *Procerastea* et *Virchowia* qui se reproduisent toujours par schizogamie, quoique la tête ait un développement bien avancé au moment de la séparation du stolon, et que le stolon s'attache longtemps à la souche, on ne voit jamais de nouveaux segments de queue se former dans celle-là avant la séparation. La régénération se réalise toujours après que le stolon s'est détaché de la souche.

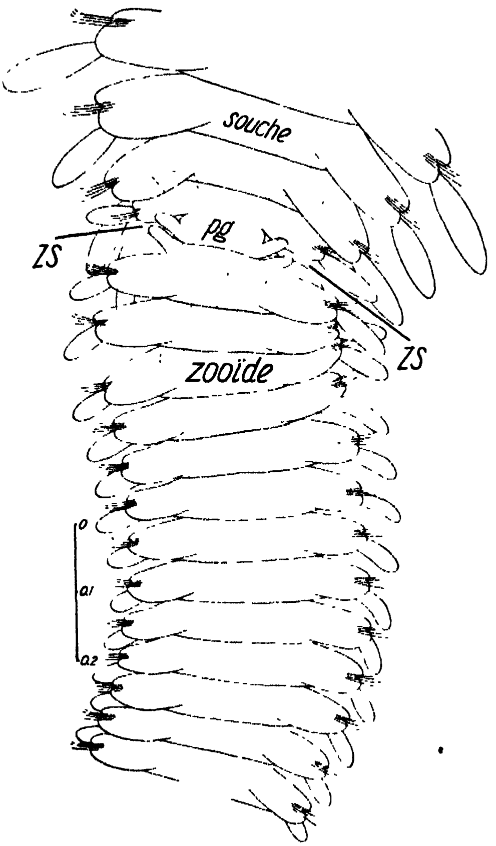

Fig. 22. Schizogamie d'*Autolytus Edwarsi* artificiellement provoquée par une coupe dans la partie antérieure du ver, vue ventrale.

Gemmation chez les Autolytidés

Il serait superflu de répéter ici que la régénération se manifeste déjà dans la souche avant que le premier stolon s'en détache et procède de suite à la formation du second et produit successivement, avant l'achèvement de celui-ci, les stolons 3, 4, 5, etc. Sans distinction de genre, *Autolytus* ou *Myrianida*, la tête du stolon apparaît dans un segment éloigné d'une certaine distance de l'extrémité postérieure du ver, et avant qu'elle ait complété son développement, un nouveau segment est formé par bourgeonnement à l'extrémité postérieure de la souche ; à la suite de l'accroissement rapide et de la segmentation de celui-ci se produit le deuxième stolon. Quand ce mode de régénération des nouveaux segments et la formation du stolon se répètent rapidement et successivement, un grand nombre de stolons font leur apparition. A ce moment, le premier segment qui se lie directement à l'extrémité postérieure de la souche constitue le zoonïte formateur d'une chaîne de stolons pour son rôle dans l'avenir. Quant à la formation de nouveaux individus, on trouve les observations de Malaquin (1892) sur les *Autolytus Edwarsi* et *Myrianida pinnigera* et les études de Mensch (1900) sur l'*Autolytus variens*, mais ils n'y traitent pas d'une façon suffisante de leur première segmentation. Le segment qui se forme d'abord comme zone de prolifération est une régénération à bourgeonnement destinée à récupérer les segments postérieurs perdus de la souche, et le mode de son développement doit suivre la règle générale de la régénération de la queue (Okada 1929 a, p. 543). Et, suivant cette règle, la première segmentation sépare une zone de croissance en avant d'un pygidium arrière. Cependant, lorsque de nombreux segments se forment rapidement comme au moment de la stolonisation gemmipare, cette segmentation se divise généralement dès le début en trois parties (fig. 23 a). Dans ce cas, le segment le plus rapproché de la souche reste

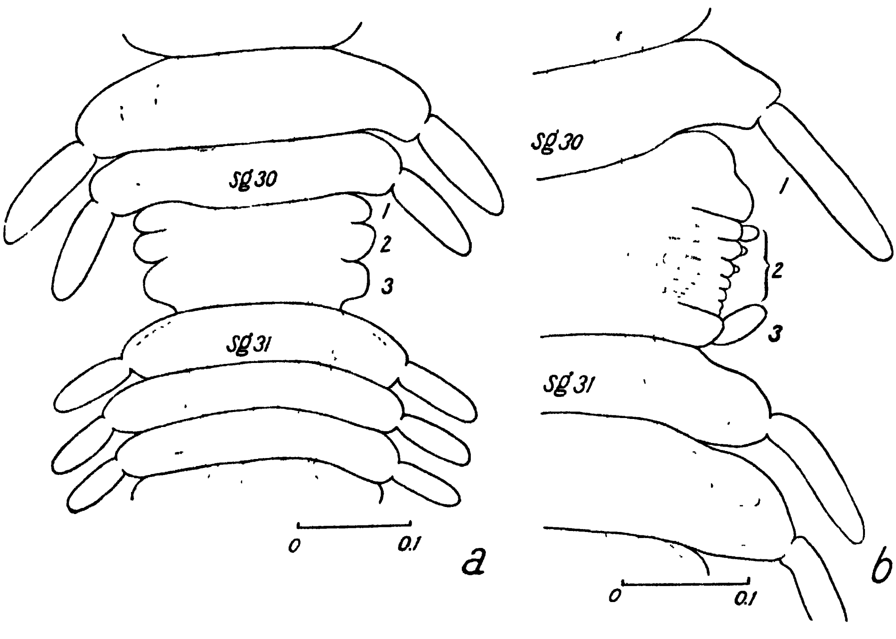

Fig. 23. Segmentation du segment intercalé au début de la gemmation d'*Autolytus Edwarsi* ; *a*, la première triple division du nouveau segment. *b*, Etat plus avancé du mode de gemmation où est bien établi le second stolon.

comme source de production des stolons en chaîne et les deux autres suivants participent directement à la formation d'un nouvel individu ; d'ailleurs, le dernier segment est destiné à former le pygidium de celui-ci. Le segment du milieu est subdivisé de suite en deux parties : la première forme le premier segment sétigère d'un nouvel individu et la seconde la zone de naissance des segments restants. Le premier segment sétigère produira plus tard une tête sur sa face antéro-dorsale, tandis que le zoonïte formateur formera successivement d'autres segments qui suivent le premier, et il gardera toujours sa place primitive qui se trouve immédiatement en avant du pygidium (fig. 23 b). Par conséquent, c'est à juste titre que Malaquin a divisé bien distinctement la formation d'une chaîne de stolons chez la *Myrianida pinnigera*, en désignant le segment, source des stolons en chaîne, sous le nom de « zoonïte formateur de chaîne » et celui qui fait la source des segments d'un individu sous le nom de « zoonïte forma-

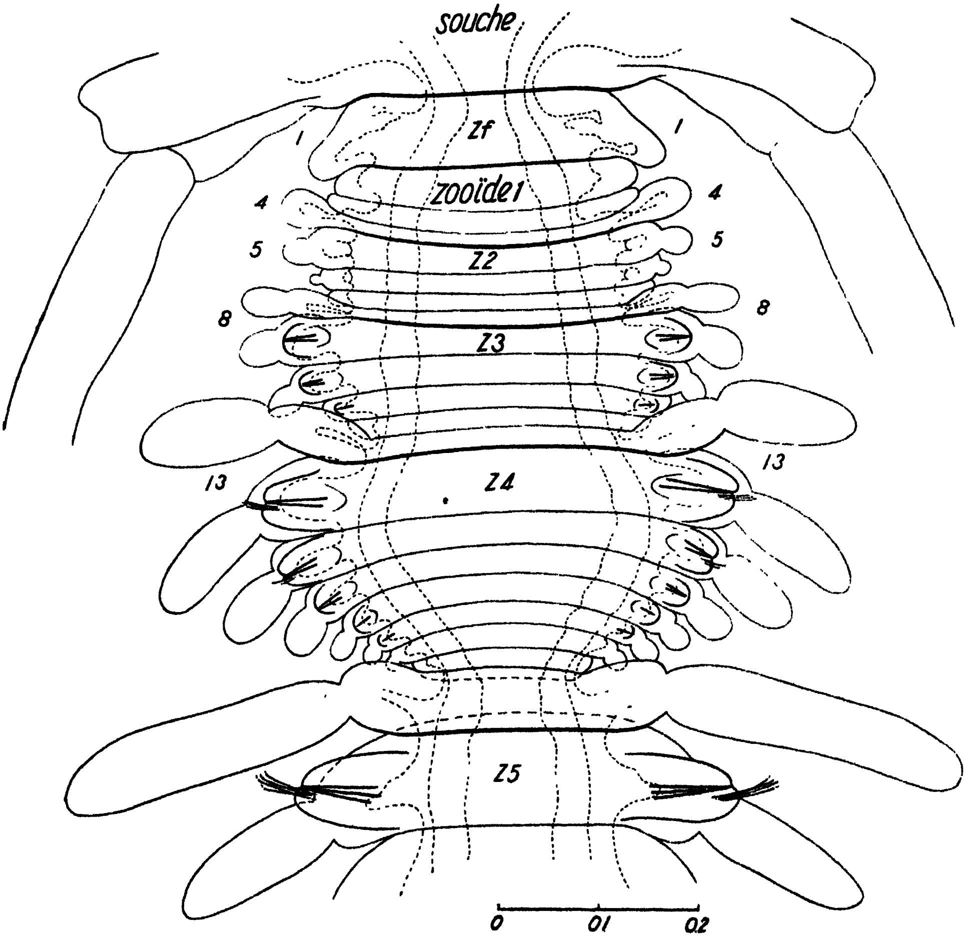

Fig. 24. Première partie de la chaîne des stolons chez la *Myrianida pinnigera*.

teur de stolon individuel ». Or, après lui, Potts (1911, p. 38) a fait une erreur indéniable en comprenant dans le zoonïte formateur de chaîne ces deux segments situés immédiatement après la souche. Il est clair que le segment qui suit immédiatement la souche, montré sur la figure 10 de Malaquin (l. c., p. 292) est la zone de prolifération des stolons en chaîne, mais le segment suivant doit être considéré comme le premier segment sétigère d'un nouvel individu. Dans ces conditions, il est naturel que les deux segments suivants c.-à-d. Zf' et As sur la figure 12 de Potts (l. c., p. 39) forment ensemble un individu, St. 1. (Il faut référer à la fig. 24).

Mensch (1900, p. 277) a donné sur le processus embryonnaire de l'*Autolytus variens* une opinion differente et que voici : — « La région embryonnaire de cette espèce consiste en 5 segments, dont les deux antérieurs sont d'une taille égale et, étant les plus jeunes de la série, peuvent être considérés comme segments embryonnaires typiques. Ces deux segments sont bien plus petits que ceux de la souche et ne présentent aucun signe de parapodes. Les autres 3, 4 et 5, sont légèrement plus avancés en développement et forment sur chaque côté une petite papille qui paraît être un parapode rudimentaire ». Cet auteur a désigné, d'une façon générale ces 5 segments du nom de segments embryonnaires, mais il n'a rien dit du segment qui faisait la source du bourgeonnement des stolons et de ceux qui participaient à la formation du plus jeune stolon. Encore ici, des deux segments considérés comme segments embryonnaires, le premier seul, qui est le plus rapproché de la souche, serait le zoonïte formateur de la chaîne et les autres auraient déjà participé à la formation du plus jeune stolon. Cependant, ce qui m'embarrasse beaucoup ici. c'est qu'il y avait déjà apparition des cirres dorsaux sur les trois segments suivants. Me basant sur mes expériences obtenues chez les *Autolytus Edwarsi* et *Myrianida pinnigera*, et surtout considérant les description de Mensch comme exactes, je voudrais établir une série du plus jeune individu avec le dernier des deux segments privés de papille dorsale et le premier des trois autres qui les suivent ; dans ce cas-là, le premier pourrait être considéré comme un type ne se segmentant pas encore en premier segment sétigère et en zone de croissance et le second comme représentant le pygidium de cet individu. Il serait alors très naturel qu'on y constate l'apparition d'une paire de cirres anaux. Venons maintenant à la signification des deux segments 4 et 5 pourvus de papille dorsale. Si on les unit aux deux segments sétigères 1 et 2 du stolon suivant, il leur manquera deux segments représentant la zone de croissance et la pygidium. En observant en détail sa figure 6 sur la planche 13, on constate que la tête fait déjà son apparition nette dans le stolon suivant ; les deux segments en question ont échappé aux observations superficielles de l'auteur américain, probablement à cause de leur inclination vers le bas. En effet, Mensch a dessiné sur la figure 7 un jeune stolon à quatre segments, dont le 1er et le 2e avaient une paire de papilles dorsales, le dernier les cirres anaux pareils et l'autre situé entre eux était privé de papilles. D'après lui, ce dernier prend naissance au segment anal et n'a aucun rapport avec le deuxième segment qui précède ce pygidium, mais cette opinion est contraire à la règle générale de

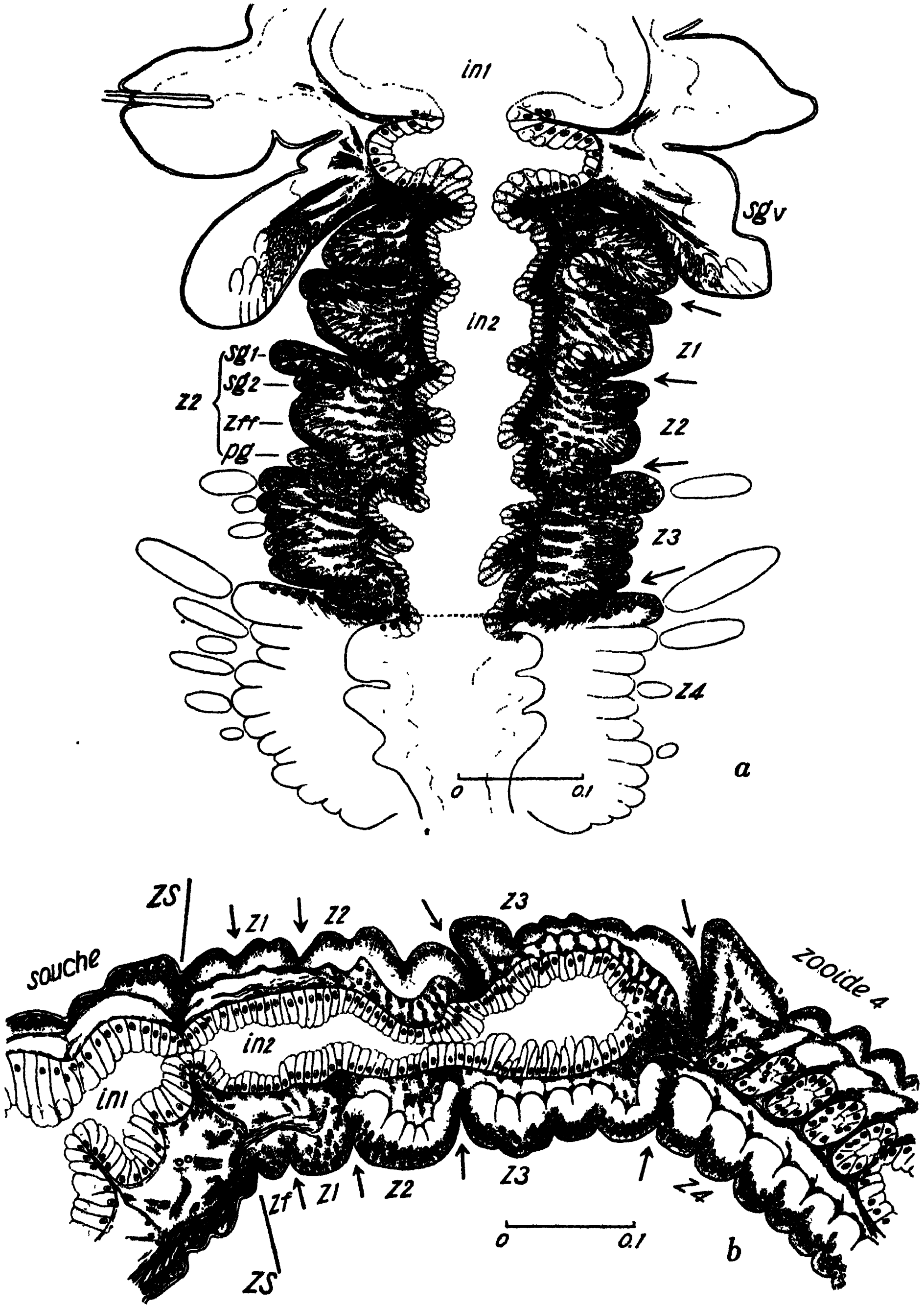

Fig. 25. *Autolytus Edwarsi:* Première partie de la chaîne des stolons dans les sections horizontale (*a*) et longitudinale (*b*). *in1*, canal alimentaire de la part de la souche; *in2*, celui de la part des stolons.

la formation de nouveaux segments chez les Annélides Polychètes en général, et loin de trouver ses partisans.

POSITION DE LA STOLONISATION

Chez les *Proceraea*, *Procerastea* et *Virchowia*, la position où est formée la deuxième tête au moment de la stolonisation est toujours déterminée à la face antéro-dorsale du 14e segment sétigère, indépendamment du nombre des segments qui constituent toute la longueur du ver. Grâce à cette détermination caractéristique, comme l'auteur l'a décrit dans une étude précédente (Okada 1934), lorsque la division a lieu sur un seul côté d'un des segments qui précèdent le 14e, et que le nombre des segments est différent à droite et à gauche en comptant à part, une formation céphalique se produira sur chaque segment correspondant au 14e en comptant à partir de la partie antérieure du corps et un stolon à double tête y sera ainsi provoqué. Cependant, quoiqu'on déduise un certain nombre de segments en faisant expérimentalement une amputation antérieure, il est impossible de déplacer d'autant en arrière la position déterminée de la formation de tête du stolon.

Chez les *Myrianida* et *Autolytus* gemmipares, la position où se produit la tête du stolon est parfois très variable; par suite celle où apparaît la chaîne des stolons l'est également; mais comme l'auteur l'a dit dans l'étude sur la *Myrianida pinnigera* (Okada 1935, p. 97), cette position ne fait pas de déplacement continuel dans les segments successifs et elle est plutôt fixée dès le début. A ce point de vue, la position en question est bien différente chez les Autolytidés et les Syllidés. Chez les dernières, le déplacement de cette position se manifeste parfois successivement dans plusieurs segments; lors même qu'il a lieu avec interruption comme chez les premières, la position n'est jamais fixée dès le début.

D'après mes observations sur la *Myrianida pinnigera*, la position la plus antérieure où apparaît la chaîne des stolons se trouve immédiatement après le 34e segment (1)* et aussi dans les suivants: 37e (1), 40e (4), 44e (6), 48e (6), 52e (7), 56e (11), 60e (7), 64e (5), 67e (0), 70e (0), 73e (0), 76e (1). En comparant ces positions à celles de division du corps indiquées par la formule de fragmentation de cet animal: H13 3 3 3 4 4 4 3 3 4 4 4 4 4 4 3 3 3. . . .xP, on trouve combien la position de fragmentation en arrière du 30e segment sétigère, telle que entre les segments 34 et 35, 40 et 41, 44 et 45, 48 et 49, 52 et 53, 56 et 57, 60 et 61, 64 et 65, 67 et 68, 70 et 71, 73 et 74, 76 et 77, est d'accord avec la position où se forme la chaîne des stolons. De plus, d'après Allen (1927, p. 874), la formule de fragmentation chez l'*Autolytus Edwarsi* est H (7 2 2) 2 3 3 3 4 4 4 3 etc. faisant une chaîne de stolons. Si, comme dans l'exemple précédent, la position de la chaîne est réglée par celle de fragmentation de cette formule, la chaîne de cette *Autolytus* doit se produire évidemment entre les segments 16 et 17, 19 et 20, 22 et 23, 26 et

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*Le chiffre mis entre parenthèses indique le nombre des individus observés.

27, 30 et 31, 34 et 35, 37 et 38. Et en examinant 205 spécimens recueillis à Plymouth, j'ai constaté en effet que cette position était entre le 22e segment (4) avant et le 40e (2) arrière: 26e (35), 30e (79), 34e(64), 37e (20) (sauf un seul cas formé immédiatement après le 33e segment), et une concordance bien nette pouvait s'apercevoir ainsi entre ces deux observations.

Maintenant, il s'agit de la position où apparaît la chaîne des stolons chez l'*Autolytus variens* rapportée par Mensch (1900). D'après lui, elle se trouve en arrière des segments suivants: 19e (1), 21e (1), 24e (2), 25e (5), 26e (4), 29e (9), 30e (16), 31e (5), 32e (19), 33e (4), 34e (20), 35e (10), 36e (5), 37e (14), 38e (13), 39e (9), 40e (6), 41e (4), 45e (2), 48e (3), 52e (2), 58e (1), et comme on le voit, elle se succède du 29e jusqu'au 41e segment. Dans ce cas-là, la position de la chaîne ne suit-elle pas la formule générale donnée plus haut?

Il faudrait pour cela tenir compte de ce qui suit: 1°) le nombre des segments qui constituent l'unité de fragmentation n'est pas constant; il est souvent variable d'après les observations d'Allen (1926) sur la *Procerastea Halleziana*, et les 3 segments d'une unité, par exemple, sont remplacés par 2 plus 1 ou par 1 plus 2, et les 4 segments par 1 plus 3 ou 2 plus 2 ou bien 3 plus 1. 2°) une chaîne de stolons peut obtenue expérimentalement par n'importe quelle position, bien entendu, dans le champs de la stolonisation, c.-à-d. dans la limite de sa formation possible (Okada 1934). 3°) comme il a été indiqué par Malaquin, la position de la stolonisation n'est pas bornée à celle où se détache le premier stolon, et elle se déplace plutôt plus en avant. La forme la plus compliquée provenant de l'entre-croisement des trois phénomènes ci-dessus énumérés serait le déplacement de la position où est formée la chaîne des stolons chez cette *Autolytus variens*, mais quoi qu'il en soit, il est indiscutable que la position de fragmentation fondamentale y participe d'une façon très nette. La position où la chaîne des stolons se forme le plus par intervalle en arrière du 42e segment et aussi dans la région s'étendant du 29e jusqu'au 41e segment, correspond toujours à celle qui est déterminée par la formule de fragmentation, à savoir, entre les segments 30–31, 34–35, 37–38, etc., sauf pour la position entre les segments 32 et 33. Pour résoudre pourquoi la formation de la chaîne est fréquente aussi dans le 32e segment, nous regrettons de ne pouvoir trouver aucune indication convenable. On doit remarquer qu'en observant à part des individus d'*Autolytus Edwarsi* de provenance différente, la position de formation de la chaîne est plus ou moins variable à partir de celle que nous venons de détailler; par exemple, dans 34 spécimens trouvés dans le Plymouth Sound, cette position se trouvait entre les segments 22–23 (3), 26–27 (18), 30–31 (12) et 34–35 (1), et sa fréquence maximum entre les segments 26 et 27, tandis que dans 46 spécimens recueillis à Wintershool à la même époque, elle était entre les segments 22–23 (1), 26–27 (1), 30–31 (12), 34–35 (22), 37–38 (7), 40–41 (2) (sauf un seul cas exceptionnel), et sa fréquence maximum plus reculée se trouvait entre les segments 34 et 35; cela proviendrait peut-être de ce que ce dernier groupe de spécimens avait une taille plus longue c.-à-d. des segments plus nombreux que les autres qui vivaient sur les côtes. Et en mélangeant ces deux cas, on peut trouver la fréquence maximum de la position en question entre les segments 30 et 31. En rapport avec le caractère d'avancement de la position de stolonisation, que l'on voit souvent dans la stolonisation de cette espèce, la position de la chaîne varie non seulement suivant les endroits de pêche, mais encore suivant les époques de la stolonisation. Enfin, nous ajoutons que la formation de la chaîne se manifeste toujours entre les segments 30 et 31 chez ces trois espèces d'*Autolytus* ayant la position déterminée de la gemmiparité: *Autolytus maculatus* d'après Potts (1911, p. 36), *Autolytus orientalis* d'après Willey (1905) et *Autolytus purpleipunctatus* d'après moi (1933 a).

LES STOLONS ET LEUR CARACTÈRE SEXUEL

La distinction sexuelle des stolons chez les Syllidés se fait uniquement par la coloration des segments génitaux ou par le degré de métamorphose des parapodes. Or, chez les Autolytidés, elle est plus remarquable: le stolon mâle forme un *Polybostrichus* ayant une paire de tentacules bifurqués à l'extrémité antérieure, et le stolon femelle une *Sacconereis* portant des oeufs a la face ventrale. L'un et l'autre présentent une structure plus développée que les stolons des Syllidés. Cependant, il n'est pas juste de distinguer les stolons, comme on le croyait, d'après la présence ou l'absence de tentacules sur la tête et le nombre de ces tentacles. La tête de la *Sacconereis* de *Myrianida*, par exemple, n'a pas de cirres tentaculaires ventraux; elle est nettement « tête pentacère ». Par contre, chez les stolons que j'ai observés à Séto et qui était du type *Ioda* de la *Typosyllis fascinata*, la structure de la tête était quelquefois plus parfaite que dans le cas de la *Myrianida* et les cirres tentaculaires étaient développés en haut et en bas des deux côtés. D'autre part, le type *Tétraglène* était bien le nom donné à la tête acere de la *Trypanosyllis zebra;* or, les stolons de la *Trypanosyllis crosslandi* (Potts 1911, p. 17, fig. 4) et de la *Trypanosyllis asterobia* (Okada 1933 a, p. 330, fig. 5) avaient nettement des tentacules latéraux ou des appendices analogues, et de plus on remarquait même, pour la première espèce le développement d'une paire de cirres tentaculaires. Pour cette raison, si on les qualifie uniquement suivant le nombre des appendices capitaux, sans tenir compte de leur caractère général, les stolons de ces *Trypanosyllis* devraient être classés plutôt dans le type *Chaetosyllis.* Il est aussi nécessaire de tenir compte pour la classification des stolons de leur souche asexuée, et il est juste de désigner les stolons du genre *Trypanosyllis* et ceux de la *Syllis ramosa* ayant une même constitution que le précédent sous le nom de *Tétraglène*, ceux de la *Typosyllis prolifera* et d'autres espèces analogues sous le nom de *Chaetosyllis* et enfin les stolons des Syllidés mieux développés que les précédents, par exemple, ceux de la *Typosyllis fascinata* sous le nom d'*Ioda.* Et quels que soient la structure et l'état de développement de la tête de chaque stolon il faut donner au stolon mâle chez les Autolytidés le nom général de *Polybostrichus* et au stolon femelle le nom de *Sacconereis;* cette désignation étant habituellement employée, je crains qu'il ne soit superflu d'y revenir. En somme, la présence ou l'absence des tentacules ou l'importance de leur nombre, ne concernent que la différence du degré de développement d'une tête. Même chez la *Saccocereis* ou chez le *Polybostrichus* ayant la tête très compliquée, le stolon se trouve au stade sans cirre au moment de son

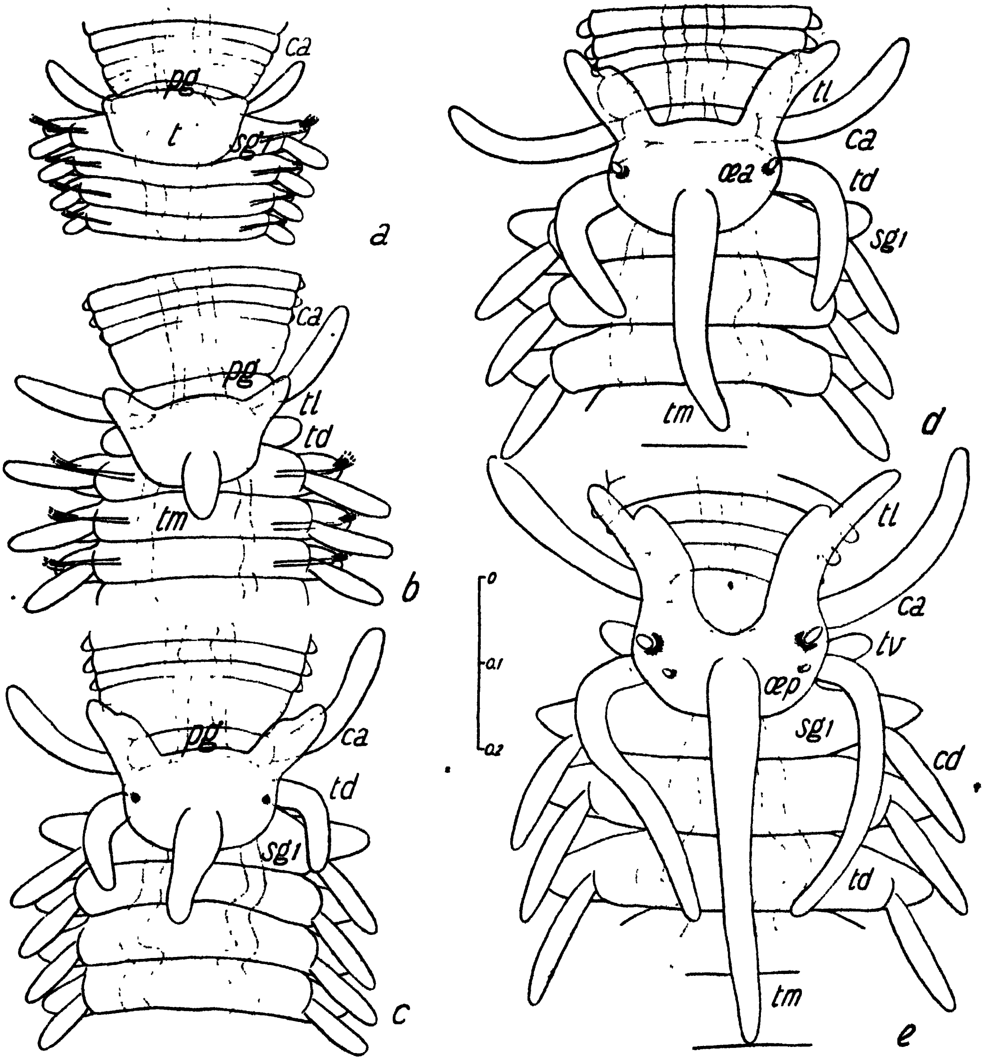

Fig. 26. Séries en développement de la tête dans la chaîne des stolons mâles chez l'*Autolytus Edwarsi*; *a*, un stade avant l'apparition de l'appendice et de l'oeil. *b*, un tentacule médian et une paire des latéraux font leur apparition. *c*, une paire de cirres tentaculaires dorsaux apparaissent et les yeux antérieurs commencent à se former. *d*, les appendices et les yeux se trouvent en même état que le précédent, leur dèveloppement étant plus avancé. *e*, une paire de cirres tentaculaires ventraux et une paire d'yeux postérieurs sont formées. *ca*, *pg*, cirre et segment anal du stolon placé immédiatement avant un autre.

apparition (fig. 26 a) et passe peu à peu au stade à trois cirres c.-à-d. ayant un cirre médian et une paire de saillies à droite et à gauche de son extrémité antérieure (fig. 26 b) ; ensuite. il arrive au stade penta-cirre par suite de l'apparition d'une paire de cirres tentaculaires dorsaux (fig. 26 c–d), enfin au stade hepta-cirre par production de cirres tentaculaires ventraux (fig. 26 e). En relation avec le développement de ces appendices, se produisent deux paires de gros yeux; l'époque de l'apparition de ceux-ci varie naturellement suivant les espèces. Le fait qu'une paire d'yeux antérieure se déplace vers le côté ventral est une indication caractérisant le stolon au stade avancé (fig. 27). Chez les stolons schizogames aucun moyen n'existe que d'observer ces phénomènes suivant le temps qu'il faut à un même individu, tandis qu'il est possible, chez les stolons gemmipares, de les constater à la fois dans une chaîne de stolons en les suivant un à un d'avant en arrière.

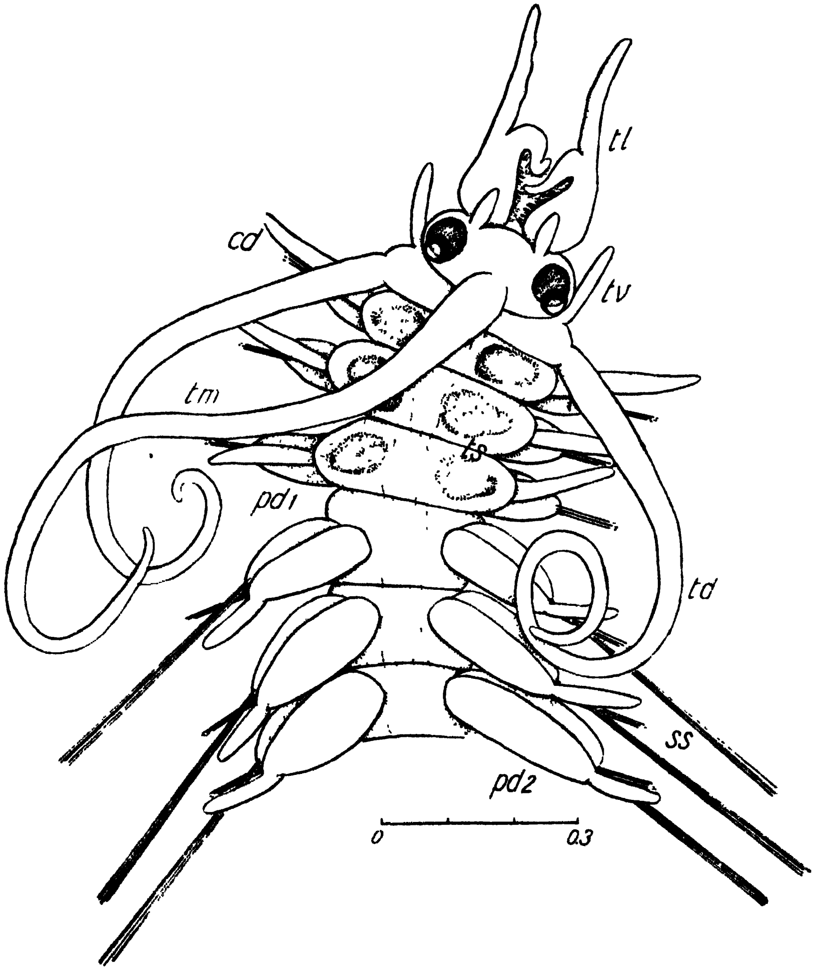

Fig. 27. Partie antérieure d'un stolon mâle d'*Autolytus Edwarsi* en développement parfait, trouvé dans le plancton. *pd1*, parapode non-modifié de la région antérieure; *pd2*, parapode modifié de la région médiane.

D'autres caractères des stolons des Autolytidés qui diffèrent de ceux des Syllidés sont : 1°) que chez les stolons mâles, la position des glandes génitales est à peu près fixée et même limitée à quelques segments antérieurs ; et chez les stolons gemmipares courts, elle est toujours limitée aux trois premiers segments (voir la fig. 27) et chez les stolons schizogames longs, à six segments. Tant chez les mâles que chez les femelles, la métamorphose des parapodes et l'apparition des soies natatoires font défaut aux segments antérieurs en question. Même dans le cas où la région antérieure non-modifiée s'étend jusqu'aux 14 segments, chez la *Proceraea longeferiens* par exemple (Okada 1929 a, p. 581, fig. 31), la production des spermatozoïdes est limitée seulement aux 5 ou 6 derniers. 2°) que dans les stolons de ces Autolytidés, les femelles portent des oeufs à la face ventrale du corps jusqu'à l'éclosion. En rapport avec ce fait, un grand développement de la néphridie est aussi remarqué chez les femelles et des glandes excrétoires particulières existent près de son orifice, ce qui diffère du cas de Syllidés. L'excrétion causerait la formation d'un sac membraneux transparent contenant la masse des oeufs. Chez les stolons gemmipares, ce sac est généralement unique et présente une forme sphérique ou ovoïde, tandis que chez les stolons schizogames longs, il est plutôt divisé en deux parties, antérieure et postérieure, inégales et parfois en plus. Chez la *Procerastea Halleziana*, les stolons portent en effet huit sacs en poire à droite et à gauche

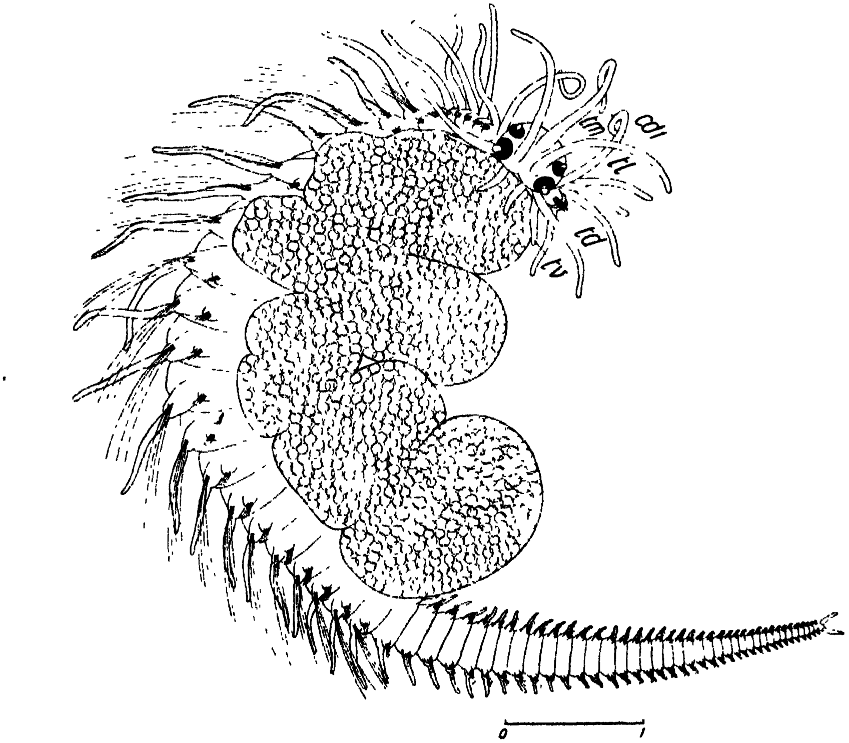

Fig. 28. Stolon femelle de *Proceraea aurantiaca* portant le sac aux oeufs.

quatre par quatre (fig. 21 b). D'autre part, comme moyen de porter la masse des oeufs, la *Sacconereis* de certaines espèces de *Proceraea*, telles que *P. picta* et *P. aurantiaca*, possède des appendices particuliers au bas de la tête et en avant du cirre tentaculaire ventral de chaque côté, et grâce à eux, elle tient solidement ses oeufs par le devant (fig. 28). Chez l'*Autolytus purpureimaculatus*, les oeufs s'accolent presque toujours à la face ventrale sans former de sac, et les stolons eux-mêmes rampent sur le sous-sol. De plus, les *Sacconereis*, seules de cette espèce, malgré leur origine gemmipare, possèdent 6 segments antérieurs non-modifiés, 20 segments médians modifiés et 10 segments postérieurs non-modifiés (cf. Okada 1933 a, fig. 11, p. 337).

Comme ce mémoire le précise dès le début, le caractère des stolons Syllidiens que nous venons d'expliquer ci-dessus en le comparant à celui des stolons asexués des autres Annélides, se trouve dans la modification sexuelle de la structure que prennent les nouveaux individus pour accomplir leur fonction spéciale de reproduction. On peut comprendre facilement que ce phénomène a des relation importantes avec la maturité des éléments sexuels. Pour en faire la preuve, on peut produire sans difficulté la formation d'un stolon par décapitation d'un individu n'ayant pas encore d'indication de stolonisation. Cependant, tant que les éléments sexuels ne mûrissent pas au cours de l'accroissement de la tête du stolon, celui-ci ne présente jamais le caractère sexuel spécifique et se trouve asexué comme une régénération à l'extrémité antérieure du corps primitif (cf. Okada 1934, fig. 2, p. 390). D'autre part, chez une des espèces qui effectuent la reproduction directe, par exemple, chez l'*Eusyllis lamelligera*, les yeux et les tentacules au stade asexué présentent une métamorphose sexuelle directe, avec la maturité des éléments sexuels. Par conséquent, ce caractère sexuel ayant des rapports directs avec la maturité des éléments sexuels pourrait se comparer aux relations entre l'hormone et les caractères sexuels secondaires des vertébrés qui varient suivant les saisons; on peut en attribuer la cause aux produits de sécrétion interne des glandes génitales ou, d'une manière plus directe à l'action humorale des éléments sexuels eux-mêmes. Dans cette hypothèse, on se heurte à un fait très embarassant, c'est que cette action humorale n'amène pas la métamorphose sexuelle de la tête asexuée de la souche dans le cas de stolonisation des Syllidiens schizogames. Mais, puisque l'influence de cette action est déjà reconnue chez certaines espèces épigames, il est naturel qu'on ne puisse la nier non plus dans ce cas-ci. On doit donc supposer que quelque chose de puissant existe en effet dans la partie antérieure du corps pour la rendre nulle, ou alors que cette action dépende du degré de sensibilité des segments de la souche. Si l'on admet cette dernière hypothèse, il faut considérer le caractère morphologique de la tête asexuée dans la souche comme absolument déterminé et cette détermination comme terminée au cours de son évolution ontogénique; or, chez les espèces épigamiques, ce caractère est considéré comme indéterminé même après la formation de la tête. Pour en avoir la preuve exacte, j'ai fait une plaie cunéiforme sur un seul côté de plusieurs segments en avant et en arrière du 14e sétigère de la *Proceraea picta* et vu le corps du ver formant là un crochet par cicatrisation de la plaie; après avoir attendu le développement des glandes génitales de ce spécimen, je lui ai extirpé, en lui conservant quelques segments antérieurs, la partie courbée en avant du segment critique et remarqué la forme de la tête qui venait de se reproduire là. Si j'avais provoqué une cicatrisation latérale entre les antérieurs et les postérieurs du 14e segment avant d'avoir opéré cette amputation, c'était naturellement pour faire exercer des actions plus

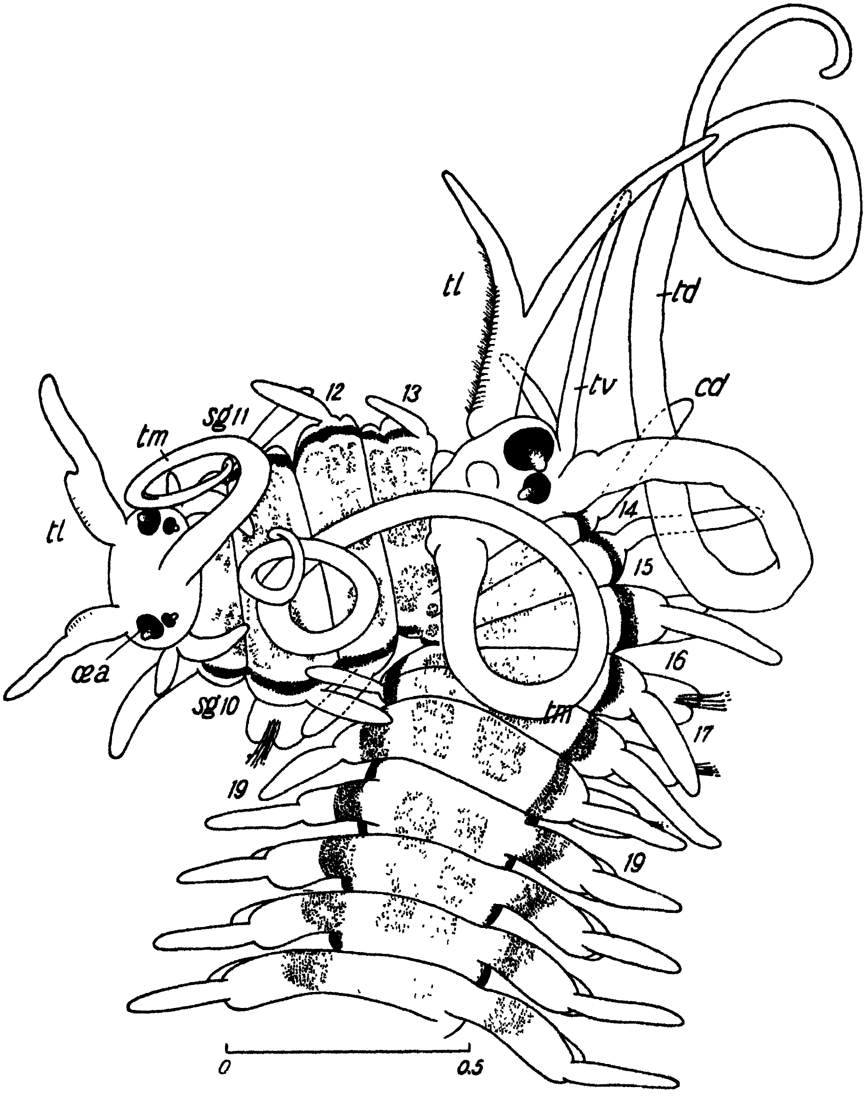

Fig. 29. Résultat de l'expérience démontrant l'effet humoral sur le caractère de la tête régénérée de la maturité sexuelle chez la *Proceraea picta*: — Régénération d'une tête de stolon sur le segment de la souche asexuée, après soudure des deux parties, antérieure et postérieure, du 14e segment et après amputation de la partie antérieure des segments au moment de la maturité des éléments sexuels.

accentuées sur le régénérateur par les éléments sexuels qui mûrissaient en arrière du segment en question. D'autre part, si j'ai choisi un ver mâle pour cette expérience, c'est que le caractère sexuel du *Polybostrichus*, stolon mâle, était très facile à reconnaître et que la pratique se faisait presque sans erreur.

D'après les résultats de cette expérience, quoique l'expression du caractère de sexe fût encore bien imparfaite sur la nouvelle tête régénérée, celle-ci était très différente de la tête asexuée ordinaire, possédant à la base des tentacules latéraux un épaississement du *Polybostrichus* et aussi des taches oculaires très grosses (fig. 29). D'ailleurs, en examinant la régénération antérieure des spécimens amputés à différents stades du développement des glandes génitales dans une région suivant le 14e segment, j'ai vu apparaître des variations de tous degrés s'étendant du *Polybostrichus* presque parfait jusqu'à la tête asexuée ordinaire. La figure 30 représente un cas où le développement du caractère sexuel est nettement inférieur, pour ce qui est de l'indication de l'influence des éléments sexuels, à celui que j'ai vu, dans l'expérience précédente, à la tête régénératrice précédant le 14e segment. En m'appuyant sur ces résultats obtenus, je peux dire avec conviction que le caractère spécial de la tête sexuée chez les stolons Syllidiens provient des influences des produits sécréteurs qui sont en relations directes ou indirectes avec la maturité des éléments sexuels.

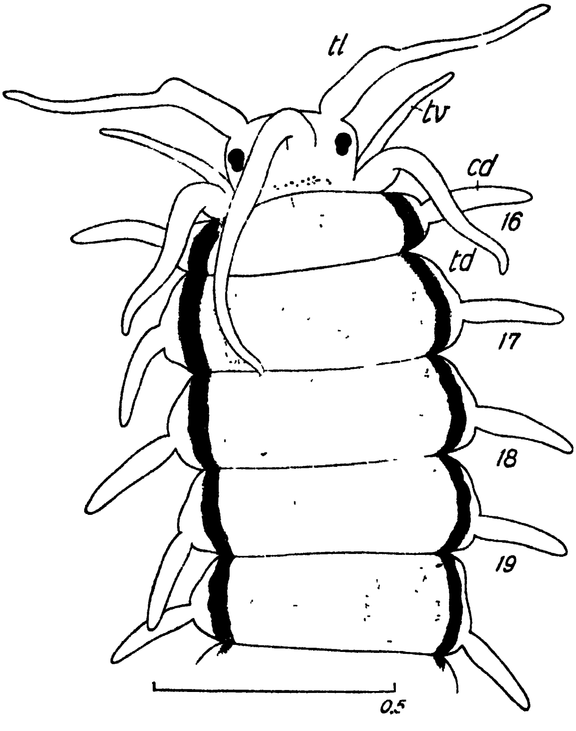

Fig. 30. Résultat de l'expérience-contrôle de la précédente: — Régénération de la tête presque asexuée dans une coupe en arrière du 14e segment avant la maturité sexuelle du ver.

La métamorphose des segments, surtout celle des parapodes en nageoires se manifeste en même temps que la tête du stolon, ayant une relation de position avec elle. Cependant, cette métamorphose ne peut être mise dans la même catégorie que les caractères sexuels de la tête précités, car une telle métamorphose paraît ne pas avoir, en plusieurs points, de relations directes avec la présence des éléments sexuels. Par exemple, comme on le sait, lorsqu'une tête de stolon est formée, par suite de l'avancement de la position de stolonisation, à un niveau plus avancé de quelques segments que le niveau précédent, ces segments qui n'ont manifesté aucun changement pour la première fois subissent maintenant aussi, en rapport avec la formation de cette tête, une transformation particulière à l'individu sexué, c.-à-d. la transformation des parapodes en nageoires, comme des segments régénérés en arrière. D'autre part, chez certaines espèces d'Autolytidés, il arrive parfois que les éléments sexuels viennent à maturité même à une autre qu'à l'époque de la stolonisation et remplissent les segments (Okada 1933 b, p. 649). En pareil cas, s'il n'y a pas de formation de la tête du stolon, la transformation des parapodes en nageoires ne se produit pas non plus. Par conséquent, il paraît que la production des éléments sexuels et la formation de la tête chez elles ou le phénomène de séparation y correspondant chez les *Haplosyllis spongicola* et *Typosyllis cirropunctata* ont une signification importante pour la transformation des parapodes. Quoi qu'il en soit, je crois que c'est une métamorphose sexuelle qui n'a aucun rapport direct avec le developpement des glandes génitales ou avec la présence des éléments sexuels et que c'est un tout autre caractère du stolon que celui qui apparaît à la tête.

Je veux donner encore quelques remarques sur la structure des stolons: c'est que, malgré que leur tête et les segments qui la suivent présentent le même degré de complication que la tête et les segments suivants de la souche, il n'existe au canal alimentaire ni pharynx, ni proventricule, ni ventricule, ni aucun appendice glandulaire de tous ces organes; que chez les Polychètes en général le pharynx n'opère jamais sa récupération par la partie intestinale postérieure, comme chez les Oligochètes. D'après mes observations sur les Syllidiens au moins, tous les organes d'origine ectodermique, depuis la bouche jusqu'à l'extrémité postérieure du ventricule*, sont formés d'ectoderme par une invagination stomodéale, même au moment de la régénération (Okada 1929 a, p. 563). Et si l'on supprime expérimentalement une partie ou la totalité d'un des organes pharyngiens sans amputer les segments antérieurs, la régénération n'aura lieu jamais en avant ou en arrière des autres régions épargnées. Par conséquent, la récupération de la partie perdue ne se manifestera jamais sans une nouvelle invagination stomodéale; il n'en est pas de même, cependant, quant à la région intestinale, et tout en lui supprimant une partie, on peut observer facilement que se produit un allongement supplémentaire de la partie restante et que se réalise quelques jours après une soudure parfaite. Parfois il arrive que lorsqu'on supprime tous les organes pharyngiens, ceux-ci ne se régénèrent plus, mais que l'intestin arrière s'allongeant, son extrémité antérieure atteigne la bouche (fig. 4, pl. XXIII.). Dans ce cas, sa structure interne ne diffère point de celle du stolon.

En observant l'état de développement de la tête du stolon, on apercevra facilement que celle-ci fait son apparition à la face dorsale d'un segment de la partie médiane du corps et que le canal alimentaire ne se rompt pas généralement jusqu'au dernier moment de la séparation du stolon (voir la fig.

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*Dans une étude précédente (1929, p. 578), j'ai cherché à l'élément intestinal l'origine des coecums ventriculaires: d'après mes observations détaillées sur sa structure cellulaire et mes expériences ultérieures, c'est toujours d'origine ectodermique par invagination stomodéale.

25). Dans un tel état, l'invagination stomodéale ne prendra jamais naissance et la faculté de régénérer le pharynx fera défaut naturellement au stolon.

CONCLUSIONS

J'ai donné ci-dessus un coup d'oeil sur la stolonisation des Syllidiens ; les explications en auraient été trop brèves dans chacun des cas, mais je pense qu'elles étaient assez suffisantes pour traiter ces phénomènes chez cette tribu des Annélides, faisant l'objet du présent mémoire.

I. Sans parler de la causalité existant entre ce mode de reproduction et la reproduction directe où le ver lui-même accomplit le rôle de reproduction par sa propre transformation directe, la première indication de la stolonisation elle-même est évidemment la séparation de la partie postérieure du corps du ver. Pour cette raison, la formation d'une tête ou d'une queue ou bien de l'une et l'autre est un phénomène secondaire qui se manifeste après. Chez les Autolytidés, le phénomène d'archytomie n'existe pas, mais il est douteux que leur stolonisation soit plus avancée que tous les cas des Syllidés. Les stolons des premières ont toujours la structure de la tête plus parfaite que les autres et encore la distinction nette des sexes ; or, chez certaines espèces de *Trypanosyllis* telles que *T. gemmipara* mentionnée par Johnson ou *T. asterobia* trouvée par moi-même, le mode de stolonisation ne paraît pas inférieur à ceux des Autolytidés les plus compliqués. Dans ces deux cas, la stolonisation serait partie de la division simple du corps, mais on ne pense pas que le phénomène en suive le même processus pour les unes et pour les autres. D'après de nombreuses observations faites, il semble qu'ils suivent indépendamment leur évolution particulière. Chez les Autolytidés la régénération postérieure apparaissant de bonne heure, avant la séparation du stolon, est toujours localisée à la face postéro-médiane du corps-souche, tandis que chez les Syllidés elle se produit à la face ventro-médiane du dernier segment de la souche. Il se produit chez les derniers, en rapport avec la formule de cette régénération postérieure, les stolons en faisceau qu'on voit chez les *Trypanosyllis*, tandis qu'on voit apparaitre chez les premiers une longue chaîne de stolons successifs qu'on observe chez les *Myrianida* et les *Autolytus*.

Chez les Autolytidés en voie de stolonisation, la tête du stolon a un bon développement et présente une haute différenciation mais la régénération de la queue est complètement réprimée dans trois genres : *Proceraea*, *Procerastea*, *Vichowia*, et les segments postérieurs perdus ne se régénèrent qu'après la séparation du stolon. Par conséquent, chez ces trois genres, plus d'un stolon n'apparaissent jamais à la fois, mais il n'est pas certain que la stolonisation se développe chez eux directement à partir de l'archytomie primitive. Ne devrait-on pas la considérer plutôt comme transformée de la gemmiparité vers la paratomie actuelle en voie d'évolution, à cause de la régénération postérieure réprimée ? Dans ce sens, on pourrait distinguer ce type de stolonisation et le cas de séparation d'un seul individu qui apparaît souvent au début de la formation de la chaîne chez l'*Autolytus Edwarsi* et chez d'autres espèces voisines.

Chez les *Myrianida*, à aucune époque de la stolonisation un seul individu ne se détachera de la souche, sauf le dernier peut-être. La première indication de la stolonisation produit immédiatement la formation de la chaîne.

Chez les Syllidés, le développement de la tête du stolon n'est pas très intense en général, et même dans le cas le plus favorable il ne dépasse jamais le degré de *Chaetosyllis*. La tête du type *Ioda* ne peut se produire dans le stolon détaché, tant que celui-ci s'attache à la souche. Or, la regénération postérieure est alors meilleure que dans le cas d'Autolytidés; surtout chez les *Trypanosyllis*, la régénération caudale est souvent bien avancée, quoique la tête du stolon n'atteigne qu'au degré de *Tétraglène* où se produisent seulement deux paires d'yeux. Naturellement, cette régénération caudale est toujours provoquée par l'apparition de la tête du stolon en arrière. Lorsque beaucoup de têtes de stolon prennent naissance en série chez les *Typosyllis*, plusieurs queues se forment aussi en série. Comme nous l'avons dit plus haut, la gemmation de la *Trypanosyllis asterobia* est un phénomène développé de cette formation polycéphalique des *Typosyllis*. En tenant compte des faits précités, nous pouvons chercher l'origine du bourgeonnement le plus intéressant chez les Syllidiens, comme l'indique le schéma suivant, dans trois types différents et diverses étapes de leur évolution respective.

Archytomie

Stolon non-mûr au moment de la séparation; après séparation, il peut se développer en un type *Ioda*. Ex.: *Typosyllis armillaris*.

Stolon déjà mûr au moment de la séparation; stolon acéphalique. Ex.: *Haplosyllis spongicola*.

Paratomie

Syllidés

Régénération antérieure inférieure à la régénération postérieure; celle-ci se manifeste à la face ventro-médiane du dernier segment de la souche; queue rudimentaire séparée en demi-rudiments. Ex.: *Typosyllis prolifera*.

- ↙ Production polycéphalique et régénération caudale dans les segments successifs. Ex.: Pluricéphalisation chez les *Typosyllis*.
  - ↓ Gemmation de la *Trypanosyllis asterobia*.
- ↘ Demi-rudiments de queue se soudant avant la séparation du stolon. Ex.: *Trypanosyllis zebra*.
  - ↓ Gemmation de la *Trypanosyllis gemmipara* et des formes alliées.

Autolytidés

Régénération antérieure supérieure à la régénération postérieure; celle-ci se manifeste à la face postéro-médiane du dernier segment de la souche.

- ↙ Régénération caudale réprimée. Ex.: *Proceraea*, *Procerastea*, *Virchowia*.
- ↘ Gemmation des *Autolytus*.
  - ↓ Phase schizogamique abrégée. Gemmation des *Myaianida*.

En comprenant ici la stolonisation de la *Syllis ramosa* comme une forme de gemmiparité, on trouve que ce n'est que la paratomie simple se produisant indépendamment mais simultanément à chacune des branches du corps bien divisées.

II. Différemment de leur souche, les nouveaux individus produits par la stolonisation ont toujours le caractère sexuel particulier; surtout chez les Autolytidés, la tête est bien différente dans les deux sexes. Et l'indication de tel caractère sexuel a été confirmée comme étant l'effet humoral provoqué par la présence des éléments sexuels dans les segments génitaux des nouveaux individus. On se demanderait alors pourquoi ce même effet n'a pas lieu en même temps dans la tête de la souche. En somme, on peut se rendre compte, par l'ensemble des faits ci-dessus observés, que la métamorphose des tentacules et des yeux n'est plus possible après le perfectionnement de leurs caractères, ne l'étant qu'au cours de leur développement. Par conséquent, si la régénération par amputation tombe juste au moment où les éléments sexuels sont à maturité, les segments antérieurs qui ne participaient pas à la formation du stolon prennent alors le même caractère sexuel que le stolon pour la plupart des cas. Parmi les changements sexuels du stolon, la transformation des parapodes en nageoires et l'apparition des soies natatoires qui se manifestent en rapport avec le phénomène de stolonisation diffèrent de celles que l'on voit sur la tête et ne sont pas sous la dépendance de l'effet direct des éléments sexuels.

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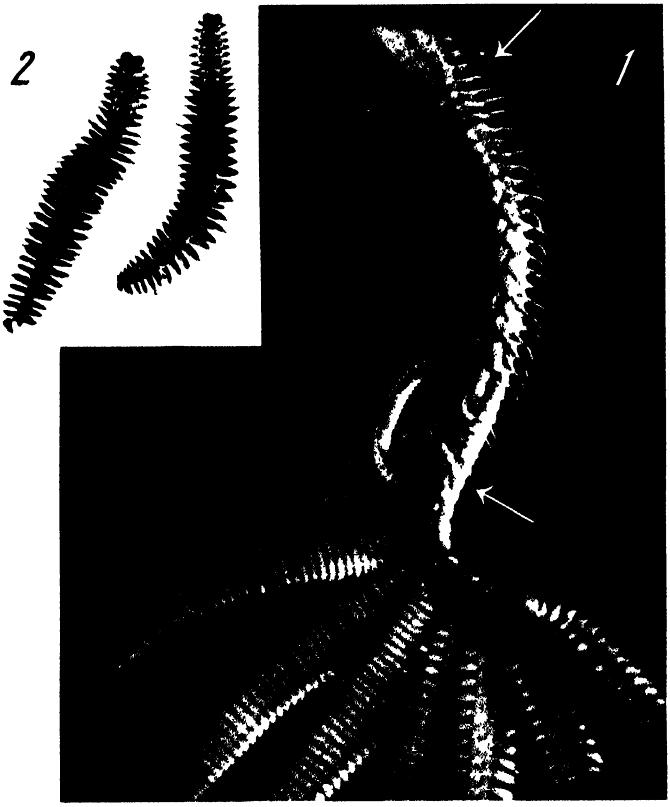
LISTE ALPHABÉTIQUE DES ABRÉVIATIONS DANS LES FIGURES

ac acicule, *an* anus, *br* bourgeon, *ca* cirre caudal, *cd* cirre dorsal, *ct* cuticule, *ds* dissépiment, *ec* ectoderme, *ge* organe génital, *in* intestin, *ms* muscle ou musculature, *n* nerf ou chaîne nerveuse ventrale, *np* néphridie, *oc* ou *oe* oeil, *ov* ovaire, *pc* proctodeum, *pd* parapode, *pg* pygidium ou segment anal, *pr* péritoine, *q* queue, *1/2 q* demi-beurgeon de queue, *sg* segment, *sg n* nouveau segment, *sg v* vieux (ou ancien) segment, *sp* sermatozoïde, *ss* soie natatoire, *t* tête, *td* cirre tentaculaire dorsal, *tl* tentacule latéral, *tm* tentacule médian, *ts* testicule, *tv* cirre tentaculaire ventral, *v* vaisseau sanguin, *vd* vaisseau dorsal, *vv* vaisseau ventral, *z* zooïde ou stolon, *zf* zoonïte formateur des individus de la chaîne, *zff* zoonïte formateur des segments d'un stolon, *zs* niveau de séparation (ou scissiparité).

EXPLICATION DES FIGURES DANS LA PLANCHE

1. Région postérieure de *Trypanosyllis asterobia* en période de stolonisation; les stolons plus jeunes et plus vieux se séparent en deux groupes, le début de chaque groupe étant marqué avec une flèche.
2. Deux stolons mâles de *Syllis ramosa.*
3. Section médiane longitudinale de la partie antérieure d'*Autolytus Edwarsi.*
4. La même du spécimen dont le pharynx est expérimentalement remplacé par l'intestin.



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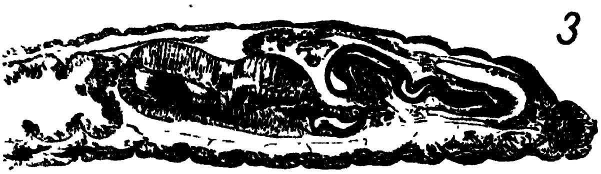

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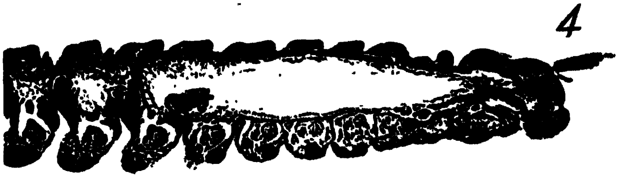

20. Studies on the Helminth Fauna of Japan
Part 20. Larval Trematodes from Marine Fishes

By Satyû YAMAGUTI

Laboratory of Parasitology, Kyoto Imperial University

(With Plates XXIV-XXV)

The trematode larvae collected from marine fishes since my previous report (Part 2 of the series) are described in the present part. Although feeding experiments have not been carried out, the morphological and ecological evidences are sufficient in some cases to identify the worms involved. It is very interesting to note that the larval trematodes found so far in Japanese marine fishes, with some exceptions, come to maturity in piscivorous marine fishes.

1. *Prosorhynchus* (*Skrjabiniella*) *aculeatus* Odhner, 1905

Pl. XXIV, fig. 1.

On July 28, 1935, some ten oval cysts were found in the fins of *Pseudorhombus cinnamomeus* (Temm. et Schleg.) from the Inland Sea. As fixed in acetic sublimate under a cover glass they measure 0.48–0.7 mm long by 0.32–0.45 mm broad and consist of an inner hyaline and an outer connective tissue membrane, the thickness of the latter increasing with the duration of infection.

As liberated from the cyst and fixed in acetic sublimate under a cover glass the larva is elongate oval and 0.5–0.73 mm long by 0.3–0.38 mm broad. The apical organ, 60–72 × 105–123 μ, is thickened and elevated at the margin and drawn out posteriorly. The unicellular adhesion gland cells are massed in the median field between this organ and the vitellaria. The pharynx, up to 0.1 mm in diameter, lies at about the middle of the posterior half of the body. The peri-esophageal gland cells are well developed. The intestine 0.1–0.15 mm wide extends a little further forward than the middle of the body.

The oval testes, 75–100 μ in length, lie one on each side of the beginning of the intestine, the left one a little further in front. The cirrus pouch extending to the left testis contains a coiled tubular vesicula seminalis and a wider pars prostatica surrounded by prostatic cells. The funnel-shaped genital sinus, into which the crooked genital lobe projects prominently, opens on the ventral side of the posterior extremity.

The oval to subglobular ovary, 60–87 × 50–78 μ, lies anterodorsal to the right testis. The vitellarian anlagen are arranged in two lateral groups at about the junction of the anterior with the middle third of the body. The voluminous excretory vesicle extends on the dorsal side from the posterior end of the body to near the middle of the right testis.

As compared with the larva which I reported from *Rhinogobius* sp. this worm is much smaller and has a relatively large pharynx, but I venture to refer it for the present to the same species.

Skrjabiniella Issaitschikow, 1928, is regarded as subgenus of *Prosorhynchus* Odhner, 1905.

2. *Prosorhynchus* (*Skrjabiniella*) *uniporus* Ozaki, 1924

Pl. XXIV, fig. 2.

In my former paper I reported this larva from *Callionymus lunatus* Temm. et Schleg. The present note is based on one of the specimens from the fins of *Acanthogobius flavimanus* from Hamanako.

As fixed in acetic sublimate under a cover slip the elliptical body covered with minute spines measures 0.49 mm in length and 0.19 mm in maximum breadth at the middle. The apical adhesive disk is 48 μ thick in the center and 75 μ in diameter. The pharynx, 51 × 54 μ, lies at the junction of the middle with the posterior third of the body. The esophagus is surrounded by a dense mass of glandular cells. The voluminous intestine 0.1 mm wide lies in the middle third of the body. The testes lie one on each side of the pharynx, the right one being 66 × 36 μ and slightly behind the left, which measures 60 μ by 27 μ. The club-shaped cirrus pouch, 0.12 mm long by 45 μ broad, extends to near the left testis; it contains a tubular vesicula seminalis, a compact mass of prostatic cells and a vesicular pars prostatica. The genital sinus opens at the posterior extremity in direct contact with the excretory pore. The ovary, 39 × 24 μ, is situated in front of the right testis at the level of the esophagus. The vitellarian anlagen are not distinctly recognizable because of inadequate staining. The wide excretory vesicle extends on the right of the cirrus pouch to near the right testis.

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3. *Gotonius* larva

Pl. XXIV, fig. 3.

A single encysted metacercaria was obtained from the tail fin of *Acanthogobius flavimanus* (Temm. et Schleg.) at Benten-Zima, October 24, 1936. As fixed in acetic sublimate under a cover slip the nearly cylindrical body measures 2.1 mm long by 0.5 mm broad. The cuticle is beset throughout with minute scale-like spines. The nearly funnel-shaped rostellum is 0.188 mm long and has a thick muscular border at its anterior end, which is 0.15 mm in diameter. It contains at the base a mass of gland cells, whose ducts open to the exterior on the apical surface. The pharynx, 90 μ in diameter, lies just behind the middle of the body. The esophagus is surrounded by numerous small gland-like cells as in the known Bucephalid metacercariae. The intestine is voluminous and extends to the posterior end of the anterior third of the body.

The oval testes lie obliquely tandem behind the middle of the body, the anterior on the right of the esophagus and the posterior behind the pharynx. The vas deferens of the anterior testis passes over the pharynx toward the left and round the left end of the posterior testis, whence the two ducts run straight backward.

The muscular cirrus pouch contains a U-shaped vesicula seminalis and a well developed pars prostatica surrounded by a dense mass of prostatic cells. There is a genital papilla projecting into the genital sinus, which opens on the ventral side 0.15 mm from the posterior extremity.

The ovary, smaller than the testes, lies immediately in front of the anterior testis. The germiduct runs backward on the dorsal side of the anterior testis and joins immediately behind it the Laurer's canal, which is markedly swollen at its proximal portion and after a sinuous course opens dorsally to the posterior testis. The ootype enclosed in a compact shell gland lies directly behind the anterior testis and a little to the right. The winding uterus passes between the pharynx and the posterior testis and ascends on the left of the intestine as far as the anterior end of the vitellaria, where it turns backward. Behind the posterior testis it forms conspicuous convolutions and finally opens from the right into the genital sinus.

The vitelline follicles are poorly developed on either side in front of the intestine and their number is unable to make out with certainty. The left vitelline duct unites with its fellow on the right side of the pharynx.

The long tubular excretory vesicle opening at the posterior tip of the body reaches to the anterior testis.

In view of morphological resemblance and the fact that the host fish is devored by *Platycephalus indicus* living in the same locality, it seems likely that this larva belongs to *Gotonius platycephali* Yamaguti, 1934.

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4. *Dolichoenterum longissimum* Ozaki, 1924

Pl. XXIV, figs. 4-5; Pl. XXV, fig. 8.

Numerous larvae of this species were obtained at Kôti, November 15 and 16, 1936, from *Callionymus altivelis* Temm. et Schleg., *Chrionema chryseres*

Gilbert and *Hoplichthys regani* Jordan et Richardson. They were encysted in the fins and muscles, especially near the bases of the pectoral and caudal fins (Pl. XXV, fig. 8).

As fixed in acetic sublimate under slight cover glass pressure, the nearly cylindrical body covered with minute spines measures 2.3–10.2 mm in length and 0.5–0.9 mm in maximum breadth. Of the subcuticular musculature the outer longitudinal and inner diagonal fibers are well developed. The anterior sucker with a wide anteroventral opening is 0.3–0.9 mm in diameter and bears on its anterodorsal margin eight conical muscular projections arranged in a semicircle. Behind the sucker there are numerous pyriform gland cells, whose ducts open to the outside along the ventral margin of the sucker as well as along the sides of the projections mentioned above.

The ventral mouth leads directly into the pharynx, which is 0.13–0.25 mm in diameter and lies usually in front of the middle of the body, but occasionally behind it. The short esophagus is directed anterodorsad and surrounded by numerous gland cells containing fine granules. The simple tubular intestine turns backward a short distance in front of the pharynx and terminates beside the cirrus pouch. It may be distended with brownish granular ingesta.

The rounded testes, 0.08-0.3 mm in length, lie obliquely tandem on the dorsal side of the intestine in the posterior fourth of the body; the anterior testis is on the right and only slightly smaller than the posterior. The right vas deferens arising from the dorsal surface of the anterior testis runs down obliquely toward the left on the dorsal side of the intestine and uterus and then backward between the intestine and the posterior testis, where it lies close parallel to its fellow, and unites with the latter before opening into the vesicula seminalis. The fusiform cirrus pouch, 0.15–0.3 mm long by 0.06–0.18 mm broad, has an exceedingly thick wall composed of lamellar muscles and is surrounded by a layer of large cells, whose vesicular nucleus contains a large compact basophil nucleolus and whose protoplasm is filled with relatively coarse mitochondria. The vesicula seminalis is small and lies at the anterior end of the cirrus pouch. The pars prostatica and prostatic cells are well developed. The genital sinus opens by a short duct lined with very thick cuticle into the ventroterminal depression* at the posterior extremity. The ovoid ovary up to 0.1 mm by 0.13 mm lies on the right side behind the anterior testis. After giving off the Laurer's canal the germiduct receives the vitelline duct behind the ovary and passes into the ootype enclosed in the compact mass of shell gland cells. The Laurer's canal opens on the dextrodorsal margin of the body at about the level of the shell gland. The uterus runs forward between the two testes and turns backward a short distance in front of the anterior testis, and passes round the right margin of the posterior testis; it lies dorsal to the intestine and cirrus pouch throughout its length and finally opens into the genital sinus at the sinistrodorsal side of the cirrus pouch. The small vitelline follicles, about 15 on each side, are situated around the vitelline ducts beginning some distance in front of the anterior testis and running backward in the dorsolateral fields. The left vitelline duct proceeds to the right in front of the posterior testis on the dorsal side of the right vas deferens, uterus and intestine, and unites at a point posterosinistral to the ovary with its fellow coming down along the ventrolateral margin of the anterior testis and the dorsomedial margin of the ovary.

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*This depression corresponds to the "urogenital pore" of Ozaki.

The tubular excretory vesicle, somewhat enlarged anteriorly, extends on the dorsal side of the intestine as far as the anterior end of the cirrus pouch or slightly further forward; it opens into the ventroterminal depression mentioned above at the dorsal or dorsolateral side of the genital pore. The main collecting vessel arising on each side near the anterior end of the vesicle runs forward in a sinuous course just outside the intestine and bifurcates at about the level of the pharynx into an ascending and a descending tubule. The cephalic nerve commissure lies dorsal to the anterior sucker near its posterior end and each posterior nerve trunk passes in the submedian line through the ventral subcuticular cell layer.

On November 18, 1936, a younger larva, apparently of this species, was found in the flesh of *Arnoglossus violaceus* Franz at Kôti. The oval cyst, 1.3 mm long by 0.75 mm broad in life, had a thick double-layered wall consisting of an inner delicate and an outer thick connective tissue membrane, and contained a crooked larva measuring 1.3 mm long by 0.3 mm broad. As fixed in acetic sublimate under a cover glass the larva is 1.4 mm long by 0.3 mm broad. The relatively thick cuticle is beset throughout with minute spines. The anterior sucker, 0.27 mm in diameter, bears a row of eight muscular papilliform projections along its anterodorsal margin. The pharynx, 90 μ in diameter, lies just behind the middle of the body. The intestine extends from a short distance in front of the pharynx to near the cirrus pouch, which measures 90 μ by 30 μ. The anlagen of the reproductive organ are not yet recognizable.

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5. *Stephanochasmus bicoronatus* (Stossich, 1883) Looss, 1901

Pl. XXIV, fig. 6.

On April 23, 1935, several subglobular cysts were collected from the body cavity of *Acanthogobius hasta* (Temm. et Schleg.) at Okinohata on the coast of the Sea of Ariake. As fixed in acetic sublimate under a cover glass they are 0.57–0.78 mm in length, and the oculate larvae, 1.06–1.9 mm long by 0.38–0.4 mm broad, gave the following measurements for the principal organs. Oral sucker 0.125 × 0.15–0.175 mm; preyharynx 0.2–0.38 mm long; pharynx 0.1–0.12 × 0.075–0.09 mm; acetabulum in middle third of body, 0.17–0.188 mm in diameter; testes oval, 63–114 × 84–100 μ, tandem near posterior extremity; ovary oval, 33–42 × 42–54 μ, at anterior end of voluminous excretory vesicle. The circumoral spines, 33 in number and 33–60 μ long, are arranged in two alternate rows except for the symmetrical ventromedian ones, which appear to be in the aboral row and are as long as the aboral nearest them as in *S. cesticillus* (Molin) of Monticelli and *S. bicoronatus* (Stossich) of Looss (fig. 2 b). On the ventral side the oral spines are definitely longer than the aboral, while on the dorsal side those of the two rows are nearly of the same length. In contracted specimen (fig. 6) the cirrus pouch containing poorly differentiated vesicula seminalis, pars prostatica, prostatic cells and ductus ejaculatorius, reaches to the ovary, but in an extended specimen 1.9 mm long it terminates about 0.12 mm in front of the ovary. The Laurer's canal turns back on itself and opens on the middorsal surface at the level of the ovary. The uterus, surrounded distally by numerous Begleitzellen, appears to join the ductus ejaculatorius near the genital pore lying immediately in front of the acetabulum. The shell gland cells form a compact mass in front of the ovary.

Similar cysts, consisting of an outer thick gelatinous and an inner thin transparent membrane, were obtained from the gills of *Sciaena* sp. and *Taenioides lacepedi* (Temm. et Schleg.) from the same locality. As fixed in alcohol the cysts from *Sciaena* sp. are about 0.7 mm in diameter, and the larvae liberated from the cyst 1.25–1.35 mm long by 0.31–0.34 mm broad. Oral sucker 90 × 135 μ; pharynx 115 × 87–90 μ; acetabulum 0.135–0.15 mm in diameter. The circumoral spines are 33 in number and arranged as in the larvae described above. Their lengths are as follows:

Ventral	oral spines	39–45 μ
„	aboral „	27–33 μ
Dorsal	oral spines	45–48 μ
„	aboral „	36 μ

From the number and arrangement of the circumoral spines it seems likely that the larvae described above belong to *Stephanochasmus bicoronatus* (Stoss.) of Looss. *Distomum imparispine* Linton, 1905, has also 33 or 34 spines around the mouth, but this species should probably be assigned to *Echinostephanus* Yamaguti, 1934.

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6. *Echinostephanus hispidus* Yamaguti, 1934

The encysted larvae of this species were found one each in the flesh of

Pseudorhombus pentophthalmus Günther and *Neopercis sexfasciatus* (Temm. et Schleg.) at Maisaka, October 23, 1936.

The double-layered cyst is subglobular and measures 1.0–1.1 mm broad in the fresh state. As dissected out of the cyst and fixed in acetic sublimate, the worm from *Neopercis sexfasciatus* is 3.9 mm in length and 0.9 mm in maximum breadth at the distended excretory vesicle, whence the body tapers gradually toward the anterior extremity. The cuticular spines beginning at the narrowest part of the neck-region about 45 μ behind the oral sucker are strong enough in the forebody, with their incurved tips projecting prominently over the surface, but become gradually smaller and sparser toward the posterior extremity, where they are almost completely absent. Of the subcuticular musculature the longitudinal fibers are well developed throughout the body, while the circular fibers form very strong bundles in the forebody. A pair of eye-spots are present. The circumoral spine, 42 in number, are arranged as in the adult described in my previous paper. Their measurements taken in life are as follows

Dorsomedian	oral spines	76 × 15 μ
„	aboral „	90 × 15 μ
Ventromedian	oral spines	33 × 9 μ
„	aboral „	42 × 11 μ
Lateral	spines	75 × 13 μ

The terminal oral sucker is nearly disk-shaped and 0.188 mm in diameter. The prepharynx is about 0.4 mm long and the pharynx 195 μ by 93 μ. The esophagus is only 70 μ long. The ceca are simple and open into the excretory vesicle near its pore. The prominent acetabulum, 0.24 mm in diameter, lies in the posterior half of the anterior third of the body.

The elliptical testes lie one behind the other near the posterior extremity, the anterior measuring 0.25 × 0.135 mm and the posterior 0.31 × 0.138 mm. The tubular cirrus pouch, 0.78 mm long by 90 μ broad at the posterior end, extends in the median line from 0.25 mm behind the acetabulum to a short distance behind the middle of the body; it contains a sinuous vesicula seminalis, a tubular pars prostatica, prostatic cells and a long ductus ejaculatorius. The latter unites at the anterior end of the cirrus pouch with the metraterm, which functions as ductus hermaphroditicus and opens outside immediately in front of the acetabulum. The ovary is 70 μ long by 75 μ broad and lies in the median line about 0.195 mm in front of the anterior testis, with the shell gland complex immediately in front. The narrow median uterus forms for a distance of about 0.46 mm a slight dilatation provided with a thick coat of gland-like cells and overlapping the cirrus pouch for most of its length. The vitellarian anlagen in the lateral fields of the hind-body begin a short distance behind the acetabulum.

The excretory vesicle is very voluminous and occupies almost the entire posterior end of the body; from its anterior end arises on each side a collecting vessel running forward.

From the above description it appears certain that this larva belongs to

Echinostephanus hispidus Yamaguti, 1934.

I take this opportunity to correct the error in my description of the adult. The ductus ejaculatorius was stated to join the metraterm near the genital pore, but upon re-examination of the original specimens I have convinced myself that the junction occurs some distance behind the acetabulum just as in the larva described above.

LITERATURE

Yamaguti, S., Studies on the helminth fauna of Japan. Part 2. Trematodes of fishes, I. Jap. Jour. Zool., Vol. 5, No. 3, 1934, p. 374-480.

7. *Tormopsolus* larva

Pl. XXIV, fig. 7.

Several elliptical, thin-walled cysts, 0.58–0.9 mm by 0.38–0.48 mm, were found near the gills of *Leiognathus rivulata* (Temm. et Schleg.) at Kôti, November 19, 1936. As fixed in acetic sublimate under cover glass pressure the larva liberated from the cyst is cylindrical and 1.65 mm long by 0.25 mm broad. The cuticle is beset with minute spines in the anterior part of the body except on the ventral median surface. The very conspicuous dark pigment masses representing the eye-spots lie dorsolateral to the pharynx, though observed further in front in the fresh state. The subterminal oral sucker measures 0.16 mm by 0.175 mm, and the pharynx 75 μ by 48 μ. The prepharynx is about 0.12 mm long. The esophagus is very short and bifurcates at the anterodorsal side of the acetabulum. The latter is 0.225 mm in diameter and lies at the posterior end of the anterior third of the body. The simple ceca extending along the sides of the body open into the cloaca at the posterior end of the body. Of the testicular anlagen one is oval, $24 \times 18\,\mu$ and lies in the median line near the posterior extremity, but the other is not recognizable. The globular ovary, 22 μ in diameter, lies in the anterior part of the posterior third of the body, with the shell gland complex immediately in front. The poorly differentiated genital ducts of both sexes unite with each other a little behind the acetabulum. The vitellarian anlagen are not yet distinctly developed. The wide tubular excretory vesicle narrows abruptly at the posterior end and forms a laterally enlarged cloaca communicating with the ceca at its lateral corners; it extends on the dorsal side to the ovary and sends out at its anterior end a pair of short lateral horns, each of which is continued anteriorly into a collecting vessel. The latter bifurcates at the level of the prepharynx into an ascending and a descending tubule.

EXPLANATION OF PLATES

Pl. XXIV

Fig. 1. Larval *Prosorhynchus (Skrjabiniella) aculeatus* Odhner, 1905; ventral view, ×100.
Fig. 2. Larval *Prosorhynchus (Skrjabiniella) uniporus* Ozaki, 1924; ventral view, ×100.
Fig. 3. *Gotonius* larva 2.1 mm long; ventral view.
Fig. 4. Larval *Dolichoenterum longissimum* Ozaki, 1924, 8.38 mm long; ventral view.
Fig. 5. Transverse section of same through cirrus pouch.
Fig. 6. Larval *Stephanochasmus bicoronatus* (Stossich, 1883); ventral view, ×50.
Fig. 7. *Tormopsolus* larva; ventral view, ×35.

Pl. XXV

Fig. 8. *Callionymus altivelis* Temm. et Schleg. infected with larval *Dolichoenterum longissimum* Ozaki.

ABBREVIATIONS USED IN FIGURES

a	acetabulum
as	anterior sucker
cp	cirrus pouch
gp	genital pore
i	intestine
o	ovary
oc	eye-spot
os	oral sucker
p	pharynx
r	rostellum
sg	shell gland
t	testis
u	uterus
v	excretory vesicle
vt	vitellarium

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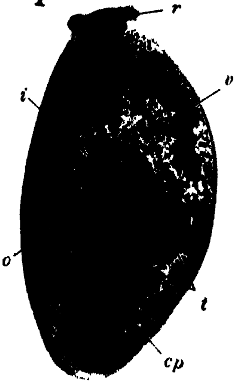
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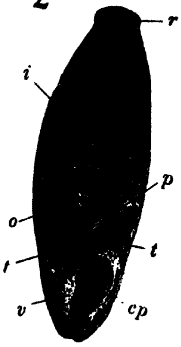
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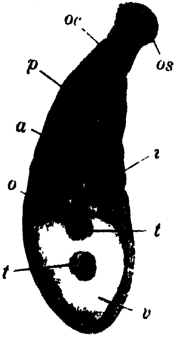
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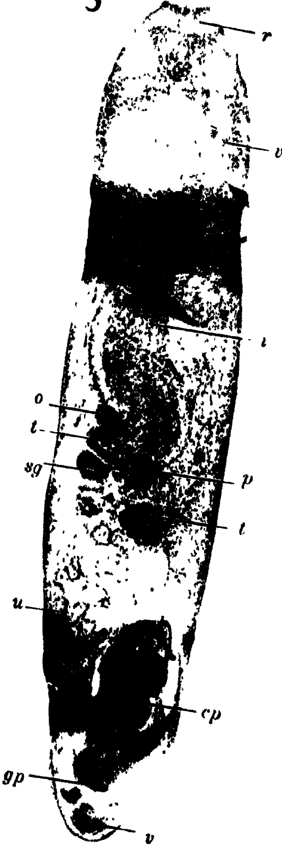
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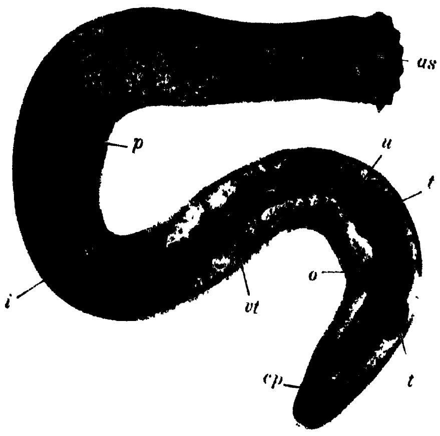
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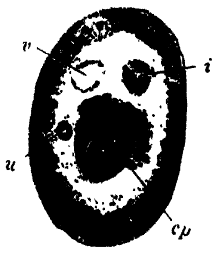
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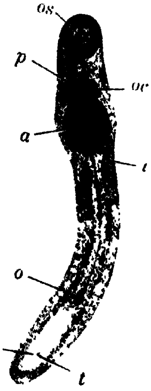
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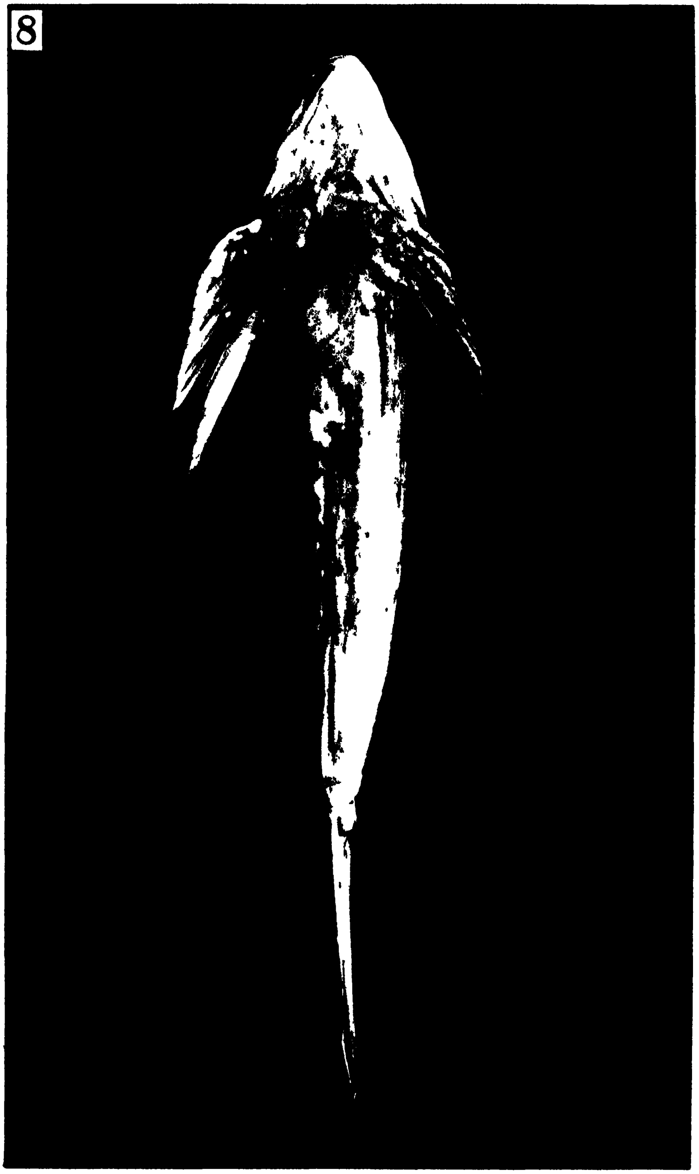
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21. A New Tapeworm (*Oochoristica ratti*) of the Family Anoplocephalidae from *Rattus rattus rattus* and *R. r. alexandrinus*

By Satyû YAMAGUTI and Itoku MIYATA

Laboratory of Parasitology, Kyoto Imperial University

(With Plate XXVI)

This tapeworm was first obtained by the junior author September 12, 1935, from the small intestine of *Rattus rattus alexandrinus* and *R. r. rattus* captured on board the "Shanghai Maru". Subsequently it was found in 2.17 per cent of *R. r. alexandrinus* and in 9.38 per cent of *R. r. rattus* captured on board the Taiwan- and Shanghai-liners, always with higher frequency for the female rats than for the male. The number of worms found in a single host varies from three to nine.

As measured in life in physiological salt-solution, the body comprising 190–230 segments is usually 65–75 mm long, but may attain a length of 180 mm or more when relaxed. The scolex is rounded, 0.39–0.48 mm broad and bears four spherical suckers, 0.12–0.14 mm in diameter, in dorsal and ventral pair. The transparent apical center of the scolex may be produced into a tongue-shaped lobe in the fresh state, but there is no true rostellum. The neck is about 1.1 mm in length with a uniform breadth of 0.52 mm in a specimen 130 mm long, and 0.15 mm long by 0.7 mm broad in a contracted one. The immature anterior segments are much broader than long and become gradually longer posteriorly; the fully mature segments are still broader than long, measuring 0.8–1.4 mm long by 1.35–2.0 mm broad; the gravid segments, up to 3.5 mm long, are definitely longer than broad unless contracted, and somewhat narrower than the broadest mature ones. The lateral margins of each segment are nearly parallel or slightly divergent posteriorly, so that they are not markedly salient at the posterior end. In contracted specimens, however, they may form a conspicuous serration.

The cuticle measures only 4–5 μ thick in transverse sections. The subcuticular musculature is poorly developed. The subcuticular cells form a thick compact layer. The inner longitudinal muscle bundles consisting of a relatively small number of fibers are separated from each other by an interval up to 65 μ in mature segments; they are markedly atrophied in fully gravid segments. There is neither definite transverse nor dorsoventral musculature. The lateral nerve trunks lie just inside the inner longitudinal muscle sheath. The wide ventral excretory stem running on the ventral side of the vas deferens and vagina and immediately outside the ovary sends out side branches at irregular intervals; the outer branches are connected with one another between the stem and the nerve trunk and form a secondary ventral stem, while the inner branches communicate with the outer branches of the dorsal stem. The inner branches of the dorsal stem unite with one another and also with their fellows of the other side by transverse anastomoses, one of which lies near the posterior end of each segment and the other at the anterior end, the latter being much narrower and lacking sometimes. At the level of the anterior end of the suckers the ascending dorsal and descending ventral stems of one side communicate with their fellows of the other side and form a complete ring.

The small globular testes are massed in the posterior half of the segment in two lateral groups of 22–43 each, the total number being 48–84, and lie mostly in one layer and partly overlapping each other in the dorsal half of the medulla. They extend toward the median line behind the vitelline gland, and may be continuous there in fully mature segments, in which they overlap the ovary at its postero-lateral part. The twisted vas deferens lies in the dorsal medulla in front of the vagina and passes between the two excretory stems. The small elongated pyriform cirrus pouch, up to 0.15 mm long by 60 μ broad in the type, contains a convoluted ductus ejaculatorius at its base lying dorsal to the nerve trunk. It does not reach to the plane in which the two excretory stems are located. The cirrus opens immediately in front of the vagina into the well developed genital atrium, which in turn opens outside at about the middle of the anterior half of the lateral margin, irregulary on right or left.

The two-winged ovary, up to 0.8 mm broad in the type, consists of distally branched tubular lobules and lies in the pre-equatorial median field, with its transverse axis slightly oblique and leaving a moderately wide free space in front. The compact vitelline gland, up to 0.37 mm broad in the type, is finely lobed on the surface and lies in the midventral medulla near the posterior end of the segment. The shell gland complex is situated in the middorsal medulla immediately in front of the vitellarium. The receptaculum seminis is elongate, small and only 25 μ wide in a section of a mature segment. The vagina passes on the dorsal side of the ovary behind the vas deferens and then between the two excretory stems and dorsal to the nerve trunk. The uterus breaks up into innumerable capsules filling up the entire medulla and slightly intruding into the cortex in some places. Each capsule contains a single egg with a thin transparent outer shell 45–52 μ by 33–36 μ* and a thick embryonic shell 32–33 μ by 25–27 μ; the embryo measures 27–31 μ by 24–27 μ and the hooks are 15–16 μ long.

This species resembles *Oochoristica brasiliensis* Furhmann, 1927, more closely than any other known members of the genus, but differs from it in the number of testes and the host.

Oochoristica ratti n. sp.

SPECIFIC DIAGNOSIS. *Oochoristica* Lühe, 1899. Body up to 180 × 2 mm, comprising 190–230 segments. Scolex 0.39–0.48 mm broad. Suckers 0.12–*

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*Measurements were made in water on specimens fixed in formol.

0.14 mm in diameter. Excretory stems just outside ovary, with numerous side branches uniting with one another. Transverse anastomoses between dorsal stems. Testes 48–84 in number, in two lateral groups, may be continuous behind vitelline gland in fully mature segments. Vas deferens and vagina between two excretory stems. Cirrus pouch up to 0.15 mm long, not reaching to excretory stems. Genital pores irregularly alternate, at about middle of anterior half of lateral margin. Ovary branched distally, pre-equatorial. Vitelline gland compact, with finely lobed surface. Receptaculum seminis elongate, very small. Vagina opening into genital atrium immediately behind cirrus pouch. Egg capsules filling up entire medulla, each containing a single egg. Outer egg shell thin, transparent, $45–52 \times 33–36\,\mu$, embryonic shell thick, $32–33 \times 25–27\,\mu$; embryo $27–31 \times 24–27\,\mu$; embryonic hooks $15–16\,\mu$ long.

Habitat. Small intestine of *Rattus rattus alexandrinus* and *R. r. rattus*.

Locality. Taiwan- and Shanghai-liners.

Type and paratypes in Yamaguti Helminthological Collection.

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Baer, J. G., Monographie des cestodes de la famille des Anoplocephalidae. Bull. Biol. de France et de Belg., Suppl. 10, 1927, p. 168.

EXPLANATION OF PLATE

XXVI

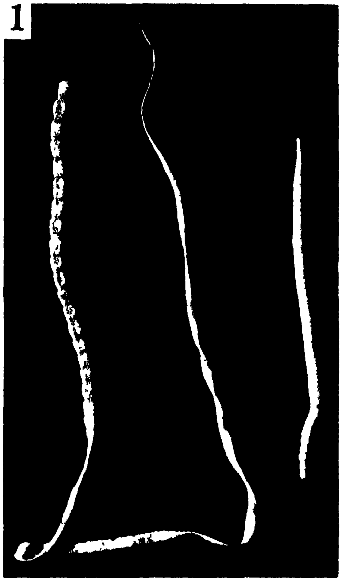
Fig. 1. Two entire worms; right contracted, left extended. Natural size.

Fig. 2. Mature segment; dorsal view, ×30. *cp* cirrus pouch, *d* vas deferens, *n* nerve, *o* ovary, *t* testes, *vg* vagina, *vt* vitellarium.

Fig. 3. Immature segment showing excretory system; ventral view, ×50. *vv* ventral vessel, *dv* dorsal vessel, *ta* transverse anastomosis.

Fig. 4. Transverse section of gravid segment; ×35. *e* egg capsule, *il* inner longitudinal muscle.

Fig. 5. Egg, ×750.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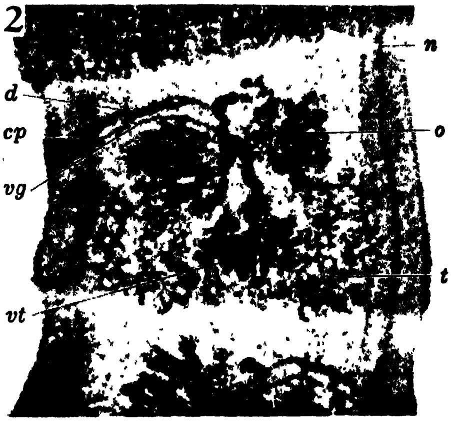
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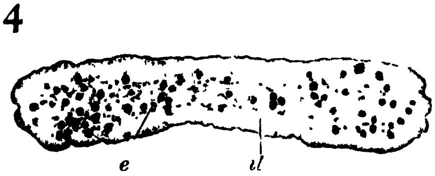
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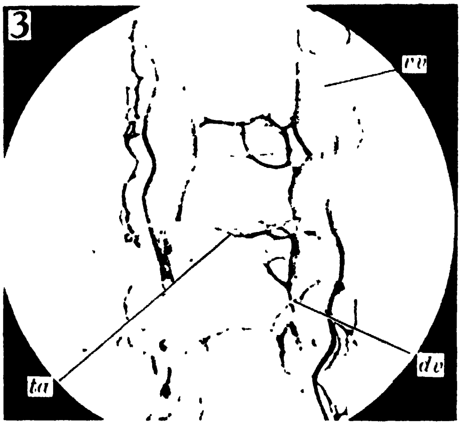
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22. A New Trematode from *Amyda japonica* (Temm. et Schleg.)

By Satyû YAMAGUTI

Laboratory of Parasitology, Kyoto Imperial University

(With 1 Text-figure)

In Part 18 of the series of my studies on the helminth fauna of Japan I described two species of trematodes, *Astiotrema orientale* and *Kaurma longicirra* Chatterji, 1936, from the intestine of a tortoise, *Amyda japonica* (Temm. et Schleg.). The identification of Chatterji's species was based on immature specimens and therefore looked upon as provisional. Recently I have obtained several mature and numerous immature specimens from the same host species and found that they differed markedly in egg size from this Indian species, so that a new name *Kaurma orientalis* is proposed for my specimens, on which the following diagnosis is based.

Kaurma orientalis n. sp.

Body elongate oval in outline, rounded more broadly at posterior end than at anterior, 3.0–4.5 mm long when mature, with maximum breadth of 1.3–1.8 mm, covered on ventral surface with minute spines. Eye-spots and cervical glands present. Preoral lip 0.11–0.15 mm thick. Oral sucker 0.4–0.56 mm in diameter. Prepharynx and esophagus very short. Pharynx 0.2–0.25 × 0.22–0.3 mm. Ceca narrow, terminating near posterior extremity. Acetabulum 0.45-0.68 mm in diameter, at about middle of body. Testes irregularly lobed when mature, median, one immediately behind the other at about middle of posterior half of body; the anterior 0.25–0.55 × 0.5–0.8 mm, the posterior 0.37–0.7 × 0.53–0.75 mm. Cirrus pouch elliptical, preacetabular 0.53–0.75 × 0.188–0.4 mm. Vesicula seminalis tubular, looped, occupying greater part of cirrus pouch. Pars prostatica* tubular, well differentiated, up to about 0.25 × 0.063 mm. Prostatic cells well developed. Ductus ejaculatorius muscular, long, eversible into stout cirrus. Genital pore about midway between intestinal bifurcation and acetabulum, a little to left of median line. Ovary transversely elongated oval, 0.15–0.23 × 0.2–0.31 mm, median or a little to left (sometimes right) of median line immediately behind acetabulum. Germiduct arising from ventral surface of ovary, joining receptaculum seminis and Laurer's canal near its origin, Receptaculum seminis club- or retort-shaped, usually posterosinistral to ovary. Laurer's canal sinuous, opening on dorsal surface at varying levels (in left

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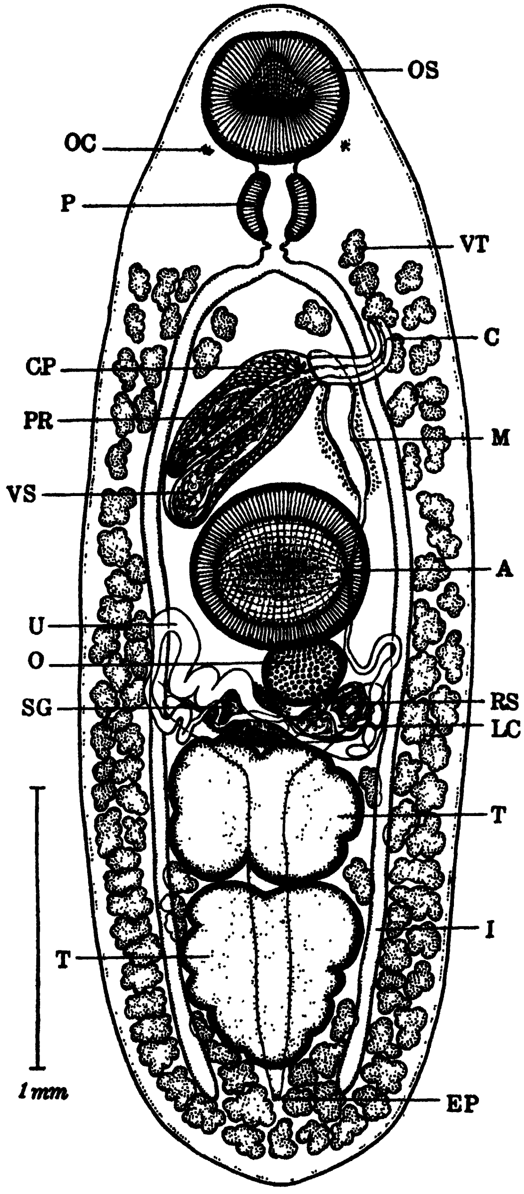
*In my emended diagnosis of the genus (p. 4) the pars prostatica was erroneously defined as undifferentiated.



Kaurma orientalis; ventral view.

A	acetabulum	OS	oral sucker
C	cirrus	P	pharynx
CP	cirrus pouch	PR	pars prostatica
EP	excretory pore	RS	receptaculum seminis
I	intestine	SG	shell gland
LC	Laurer's canal	T	testis
M	metraterm	U	uterus
O	ovary	VS	vesicula seminalis
OC	eye-spots	VT	vitellarium

submedian line at level of posterior end of ovary in the type). Shell gland compact, between ovary and anterior testis. Uterus coiled on the right, then on the left, of ovary, reaching to ventral side of intestine on each side. Metraterm strongly muscular, surrounded by Begleitzellen, medial to left cecum. Eggs oval, thin-shelled, 87–105 × 60–69 μ in life. Vitellaria lateral to ceca for their entire length, partly medial to them, continuous across median line between excretory pore and posterior extremity. Vitelline reservoir median, anterodorsal to anterior testis. Excretory vesicle tubular, dorsal to testes, opening on middorsal surface at level of cecal ends, bifurcating into short widely divergent arms on dorsal side of anterior end of anterior testis. Collecting vessel arising from tip of each arm, divided into an anterior and a posterior tubule on ventral side of cecum of its own side at a level of posterior part of acetabulum or immediately behind it.

Habitat. Small intestine of *Amyda japonica* (Temm. et Schleg.).

Locality and date. Korea; May 5, 1937.

Type and paratypes in Yamaguti Helminthological Collection.

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Yamaguti, S., Studies on the helminth fauna of Japan. Part 18. Two species of trematodes from the intestine of a tortoise, *Amyda japonica* (Temm. et Schleg.). Published by the author, March 25, 1937, p. 3–4.

23. Drosophila Species of Japan and Adjacent Localities

By Hideo Kikkawa and F. T. Peng

Zoological Institute, Kyôto Imperial University, Kyôto, Japan

(With 29 Text-figures, 2 Tables and Plates XXVII–XXXII)

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I. Introduction

No comprehensive study of the Japanese species of *Drosophila* has been made, and our knowledge of this genus inhabiting the Japanese Islands outside Formosa is very fragmentary (Coquillett 1898, Duda 1922–1929, Esaki 1932, Kamizawa 1934, Kurisaki 1925, Matsumura 1931, Sturtevant 1921, 1927). This was the first cause which induced us to a systematic study of this group.

The second reason for making this attempt is that, with the progress of the works on the genetics of the *Drosophila* material obtained from Japan and adjacent localities, the data concerning the taxonomy and the geographic distribution of this group have gradually accumulated, Thus, it has become desirable to arrange them suitably. This paper is thus intended to be of some value not only to taxonomists, but also to geneticists, cytologists and other investigators of *Drosophila.*

This study has been made possible only by the favors and encouragement received from many different sources. It would not be possible to mention

here all those who have helped us. There are, however, several persons to whom our thanks are especially due. Professor T. Komai has kindly given us every facility for collecting the material, and much valuable advice and criticism in pursuance of this work. Dr. M. Chino and other members of our laboratory have supplied valuable information concerning our investigations. Professors A. H. Sturtevant and W. P. Spencer have sent us specimens of several living American species, properly named, and these have been very valuable for comparison with Japanese ones. Through the kindness of Drs. J. C. H. de Meijere and O. Duda, we have obtained many valuable papers concerning the taxonomy of Drosophilidae. Dr. R. Takahashi has furnished us the names of *Drosophila* species preserved in the Department of Agricultural Research Institute, Government of Formosa. We likewise acknowledge with gratitude the assistance of Mr. Y. Makino who made accurate drawings for this paper. The general style of the paper has been arranged by the senior author, and the studies of genital apparatus of each species have been investigated by the junior author.

II. Collection of material

Great effort has been made for several years to obtain as many specimens of *Drosophila* as possible. For our purpose, living material was especially desired. Therefore, many traps were sent to persons who live in various localities. For the trap, a bottle with a broad neck was employed. Ripe bananas, apples, peaches and other decaying fruits were placed on the bottom of the bottle, and stout string was tied around the bottle neck to facilitate its hanging in a convenient position on branches of trees, bushes, etc.

By this method the great majority of the specimens were collected. But a few species such as *D. transversa*, *D. bizonata* and *D. busckii* prefer fungi, sap or excrement to decaying fruits.

Except in special cases, the material thus brought into our laboratory was bred in a suitable culture-medium, and the offspring were examined carefully. In this paper, therefore, only the species which were studied on sufficient material from various view-points, are described. The species examined by the specimens preserved in alcohol or "pinned" material alone, are disregarded except in a few cases, because investigations based on such materials are rather unreliable.

III. Systematic accounts

For the sake of convenience, the method of classification now current among most taxonomists of *Drosophila* is used in this paper. The following represents the systematic position of *Drosophila*:

Class Insecta
  Subclass Pterygota

Order Diptera
Suborder Cyclorrhapha
Family Drosophilidae
Genus *Drosophila.*

Since 1922, Duda has separated the genus *Drosophila* into a number of subgenera. Malloch has suggested that some of the species which Duda placed into *Mycodrosophila* should be transferred to *Drosophila.* But we do not wish to discuss the problem in detail here. As the result of examination of our material, we may include the following groups into the genus *Drosophila*: *Paradrosophila*, *Spinulophila* (*Acanthophila*) and typical *Drosophila.*

(1) Imagos

The structures of imago and the technical terms used in this paper, are shown by illustrations. In Plate XXVII is represented the schematic structure of *Drosophila komaii.*

According to Fallén (1823), the genus *Drosophila* is stated to have the following characteristics:
Head: Arista plumose; vibrissae and ocellars present; three orbitals, lowermost proclinate, upper two reclinate, middle one smaller than the others.
Thorax: One or more humerals; one presutural; two notopleurals; two supra-alars; two postalars; one to three sternopleurals; mesopleurae bare; two dorsocentrals; prescutellars generally absent; two pair of scutellars, disk of scutellum bare, posterior ones crossed; acrostichal hairs in six or more rows in front of transverse suture.
Leg: Preapicals evident at least on third tibiae.
Wing: Costa twice broken, reaches apex of fourth vein; discal and second basal cells confluent; anal cell present, often incomplete.

Though the above characteristics are not constant, they may be of use in deciding the genus. The most difficult point in classification is that there is no constant feature for distinguishing the species. For example, the acrostichal hairs between the anterior dorsocentrals, which are very convenient

Table 1

Number of rows of acrostichal hairs in some species of *Drosophila*

Rows of acrostichal hairs / Species	6	7	8	9	Total
D. ananassae	7	4	39	0	50
D. melanogaster	0	3	58	1	62
D. rufa	3	6	17	0	31
D. sordidula	17	9	17	0	43
D. virilis	43	6	1	0	50

for classification, vary in rows in different individuals (Table 1). Similarly, the costal-index varies in individuals of the same species according to temperature. Therefore, as stated above, the identification must be based on sufficient investigations from various view-points.

The following key to species by imagos was chiefly made on the male specimens, because the characteristics of the female are less distinct than those of the male.

The general differences between the two sexes are: (1) The male is usually smaller than the female in both size and length. (2) In general, there are many long hairs which stand erect on tarsal joints of the prothoracic leg of male. But, these hairs are very small in number or quite absent in the female. (3) The external genital organs are distinctly different in the two sexes.

Key to species by the imagos

(1) A pair of small prescutellars present; blackish species (Pl. XXXI a)
D. (*Paradrosophila*) *coracina sp. nov.* (p. 523)
No prescutellars .... (2)
(2) A row of short black spinules, rather closely placed, on the apical half the antero-ventral surface of the fore femur in both sexes (PL. XXVII G) .... (3)
No such spinules .... (4)
(3) Reddish species; the greatest width of cheeks about one-tenth height of eye. In male, front silvery; pleurae pale yellow, with a distinct broad reddish brown stripe on each side (PL. XXVII A-H; Pl. XXXII)
D. (*Spinulophila*) *komaii sp. nov.* (p. 525)
Yellowish species; the greatest width of cheeks about one-third height of eye. In both sexes, front dull brownish yellow; wing clouded at tip of longitudinal veins and on posterior crossvein; A single bristle at tip of first costal section (Figs. 5, 6; Pl. XXXI b)
D. (*Spinulophila*) *immigrans* (p. 524)
(4) Acrostichal hairs in six rows .... (5)
Acrostichal hairs in eight rows .... (12)
(5) Yellowish species .... (6)
Blackish or brownish species .... (11)
(6) In male, mesonotum reddish brown, with four distinct yellow stripes; pleurae black; coxa of prothoracic leg black; large species (Pl. XXXI c)
D. grandis sp. nov. (p. 543)
Mesonotum unmarked .... (7)
(7) Abdomen spotted .... (8)
Abdomen banded .... (9)
(8) Wings clouded at the tip and on both crossveins (Pl. XXXI d)
D. nigromaculata sp. nov. (p. 537)
Wing clear (Fig. 24)
D. transversa (p. 537)
(9) In male, two oblique combs of short black bristles on the inner surface of basal tarsal joint of prothoracic leg; a few stout black bristles on the distal part of second tarsal joint of the same leg; very small species (Figs. 9, 10)
D. bipectinata (p. 527)
In male, several transverse rows of blackish brown bristles on the ventral surface of the first and second tarsal joints of prothoracic leg. The bristles of these rows

become yellowish in color as they approach the base of joint (Figs. 7, 8; Pl. XXXI e)

D. ananassae (p. 526)

In male, no marked combs on the tarsal joints of prothoracic leg (Pl. XXXI f)

D. bizonata sp. nov. (p. 532)

In male, very distinct black combs on the first and second tarsal joints of prothoracic leg .... (10)

(10) Pleurae of male yellow, with a broad dark-brownish stripe on each side (Figs. 12, 13)

D. rufa sp. nov. (p. 529)

Pleurae of male unmarked; face snowy white; last abdominal segment black in color (Fig. 11; Pl. XXXI g)

D. aurana (p. 528)

Pleurae of male unmarked; face pale yellow; last abdominal segment yellowish brown in color; the number of teeth in the comb of first tarsal joint is over 20 (Fig. 14)

D. montium (p. 530)

Pleurae of male yellow; face yellow; last abdominal segment yellow in color; the number of teeth in the comb of first tarsal joint is less than 20 (Fig. 15)

D. nipponica sp. nov. (p. 531)

(11) Only one prominent oral bristle; a few prominent bristles on each palpus; the greatest width of cheeks about one-fifth height of eye; abdominal bands of female not interrupted; wing somewhat dusky; large species (Fig. 25; Pl. XXXI h)

D. sordidula sp. nov. (p. 539)

The ratio of second oral bristle to first, irregular, but less than 1.0; a few prominent bristles on each palpus; the greatest width of cheeks about one-fourth height of eye; abdominal bands of female generally interrupted in the middle and lateral parts; wing slightly brownish (Pl. XXXI j)

D. melanissima (p. 538)

Second oral bristle about one-half length of first; only one prominent bristle on each palpus; the greatest width of cheeks about one-third height of eye; abdominal bands of both sexes are not interrupted; wing clear (Fig. 26; Pl. XXXI k; Pl XXXII)

D. virilis (p. 540)

(12) Mesonotum gray, with many dark brownish spots (Fig. 29; Pl. XXXI i)

D. repleta (p. 544)

Mesonotum, pleurae yellow, with several distinct dark-brownish stripes; face whitish in color (Fig. 27)

D. busckii (p. 541)

Mesonotum not distinctly marked or unmarked .... (13)

(13) Yellowish or reddish species .... (14)

Blackish or brownish species .... (18)

(14) A blackish spot present in the tip of wing (Fig. 23; Pl. XXXI l, Pl. XXXII)

D. suzukii (p. 536)

Wing clear .... (15)

(15) No marked combs on the tarsal joints of prothoracic leg of the male, abdomen yellow with a dark brownish band on each of the four basal segments, which is interrupted in the mid-dorsal part; very large species (Pl. XXXI m)

D. histrio (p. 544)

In male, an oblique comb of short stout black bristles on the inner distal surface of the basal tarsal joint of prothoracic leg (Figs. 20, 21; Pl. XXXI n)

D. melanogaster (p. 534)

The eye is larger than that of *melanogaster*; genital arch of the male is distinctly different from that of *melanogaster* (Fig. 22)

D. simulans (p. 536)

In male, several transverse rows of blackish brown bristles on the ventral surface of the first and second tarsal joints of prothoracic leg. The bristles of these rows become yellowish in color as they approach the base of joint (Figs. 7, 8; Pl. XXXI e)

D. ananassae (p. 526)

In male, two oblique combs of short, stout black bristles on the inner surface of the basal tarsal joint of prothoracic leg; a few stout black bristles on the distal part of the second tarsal joint of the same leg; very small species (Figs. 9, 10)

D. bipectinata (p. 527)

In male, two transverse combs of a few stout black bristles on the undersurface of the basal tarsal joint of prothoracic leg; similar combs on the same surface of the second tarsal joint .... (16)

Two longitudinal combs of stout black bristles on the first and second tarsal joints of prothoracic leg .... (17)

(16) There is a blackish spot in the groove located on the posterior base of the coxa of the prothoracic leg (Figs. 17, 18; Pl. XXXI p)

D. lutea sp. nov. (p. 533)

No such blackish spot (Fig. 19; Pl. XXXI o)

D. takahashii (p. 534)

(17) Ground color of mesonotum yellow, but somewhat brownish yellow at the base of wing; the sex comb of the second tarsal joint overlaps the third one; 4V-index is less than 2.0 (Fig. 16; Pl. XXXI q)

D. ficusphila sp. nov. (p. 531)

Ground color of mesonotum yellow; but in male, there is a broad dark-brownish stripe on each side of pleurae (Figs. 12, 13)

D. rufa sp. nov. (p. 529)

(18) Wing clear; brownish species (Fig. 28)

D. funebris (p. 542)

Wing dusky .... (19)

(19) Only one prominent oral bristle; carina broad; halteres pale brown (Fig. 25; Pl. XXXI h)

D. sordidula sp. nov. (p. 539)

Second oral bristle about one-half length of the first; carina narrow; halteres white; wing pointed at the tip (Pl. XXXI r; Pl. XXXII)

D. subtilis sp. nov. (p. 541)

(2) Eggs

All the species investigated, lay white eggs varying from 0.35 to 0.55 mm in length, with a fine meshwork of raised lines over their surfaces. The structures of filaments at the anterior end are different in number and shape in different species, and afford excellent specific characters.

Key by eggs

(1) Eight or nine filaments (Fig. 1 A)

D. coracina

Two filaments .... (2)
Three filaments .... (3)
Four filaments .... (4)

(2) Tip of the filaments, rather rounded.

D. ananassae, D. bipectinata, D. lutea, D. melanissima, D. melanogaster (Fig. 1 C), *D. simulans, D. takahashii* (Fig. 1 B)

Tip of the filaments, tapering.

D. auraria, D. ficusphila, D. montium (Fig. 1 D), *D. rufa, D. suzukii*

(3) Median filament thicker than either of the two lateral ones.

D. transversa (Fig. 1 E)

(4) Four filaments.

D. bizonata, D. busckii, D. funebris, D. grandis, D. immigrans, D. komaii (Fig. 1 F), *D. repleta, D. sordidula, D. subtilis, D. virilis.*

Species not examined: *D. histrio, D. nigromaculata, D. nipponica.*

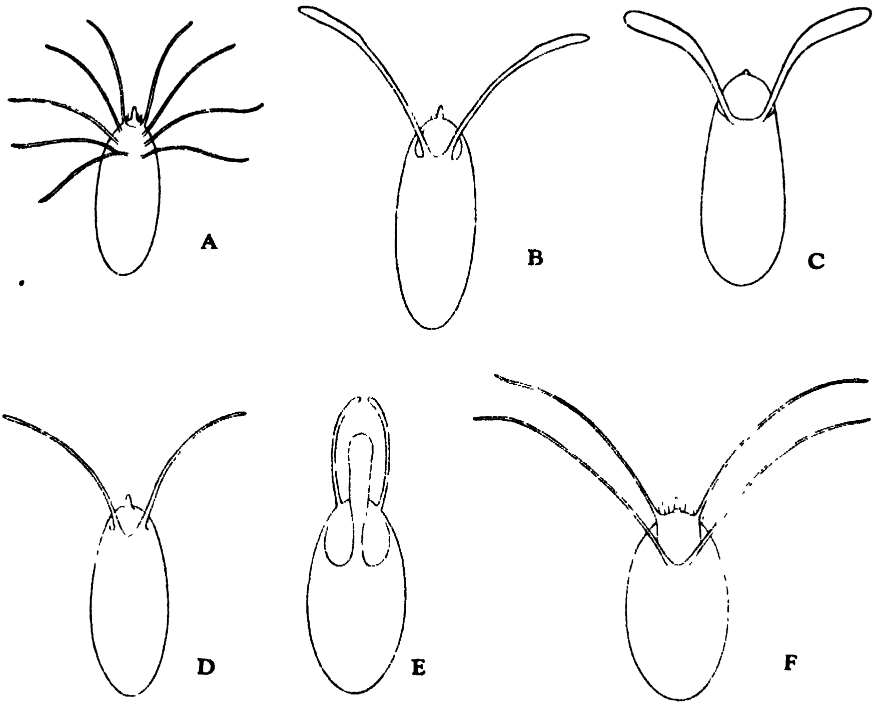

Fig. 1. Eggs of *Drosophila* species.
A, *D. coracina*, B, *D. takahashii*, C, *D. melanogaster*, D, *D. montium*, E, *D. transversa*, F, *D. komaii.*

(3) Larvae

According to Keilin (1915), the larvae of *D. melanogaster* pass through three stages, separated by two larval molts. We have not examined the two younger stages, nor studied the transitions between them. The following accounts all apply to the third larvae.

The body is divided into twelve visible segments (Fig. 2). The first segment bears a pair of cephalopharyngeal skeletons (jaws) and anterior spiracle processes. Although no study has been made here, they are certainly very useful for specific distinction (de Meijere 1916, Sturtevant 1921).

There are minute hooklets (warts) scattered over the surface of the larva, but these are not easily seen except in eight bands of several rows, which lie on the ventral surface of the larva, at the anterior edge of each abdominal segment (Fig. 2, Pl. XXX a b).

The hooklets of some species are blackish in color, but those of other ones are colorless or slightly tinged; and these afford excellent taxonomic characters. There are several processes (pseudopodia) on the last segment. From the upper posterior part of this segment arise the posterior spiracle processes. The color of these processes in most species is yellow or reddish yellow, but black in *D. immigrans*.

The fully grown larvae of *D. coracina* and of *D. subtilis* skip in the same way as do those of *Piophila* and a few other Acalypterae. Sturtevant (1921) has also observed a similar behavior in the larvae of *D. cardini* and *D. saltans*.

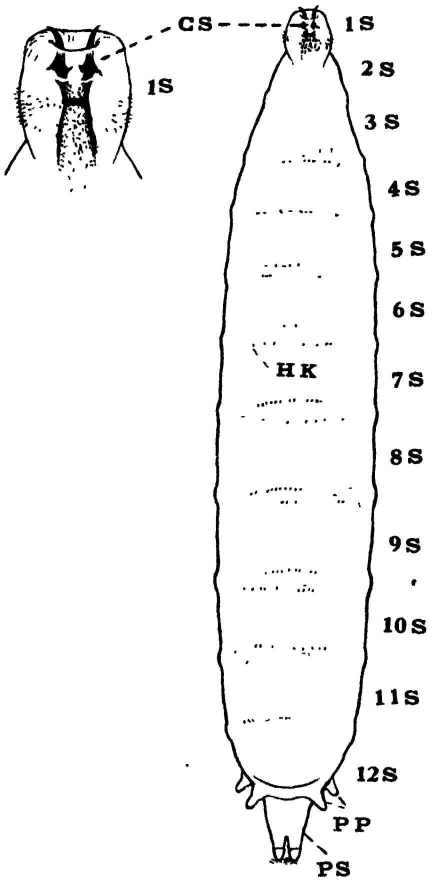

Fig. 2. Ventral view of the third larva of *D. melanogaster*.
1S-12S = First segment-Twelfth segment
CS = Cephalopharyngeal skeletons (jaws)
HK = Hooklets (warts) PP = Pseudopodia
PS = Posterior spiracle processes

Key by larvae

(1) Tip of the posterior spiracles black in color.
D. immigrans
Tip of the posterior spiracles yellow or reddish yellow in color..............(2)
(2) About six large branched processes on the dorsal surface of each segment from the fourth to the twelfth.
D. busckii

No such large processes ....(3)

(3) Hooklets on the ventral surface blackish in color.

D. ananassae, *D. auraria*, *D. bipectinata*, *D. ficusphila*, *D. lutea*, *D. melanogaster* (Fig. 2; Pl. XXX a b), *D. montium*, *D. rufa*, *D. simulans*, *D. subtilis*, *D. suzukii*, *D. takahashii*

Hooklets on the ventral surface, colorless or tinged slightly.

D. bizonata, *D. coracina*, *D. funebris*, *D. komaii*, *D. melanissima*, *D. nigromaculata*, *D. repleta* (brown), *D. sordidula* (slightly yellow), *D. transversa*, *D. virilis*

Species not examined: *D. grandis*, *D. histrio*, *D. nipponica*.

(4) Pupae

Descriptions or figures of puparia of *Drosophila* have been published by the following authors; Comstock (1893), Howard (1900), Unwin (1907), Malloch (1915), Strasburger (1935) etc.

Drosophila, like other cyclorrhaphous Diptera, pupates within the last larval skin. The anterior spiracles are extruded to form the horns of the puparium. The length of the stalk of horns in proportion to the total length of the body (hereafter designated as SB), and the number of anterior spiracles (designated as NA), are different according to the species. In Figure 3, are shown several examples of the anterior parts of pupae.

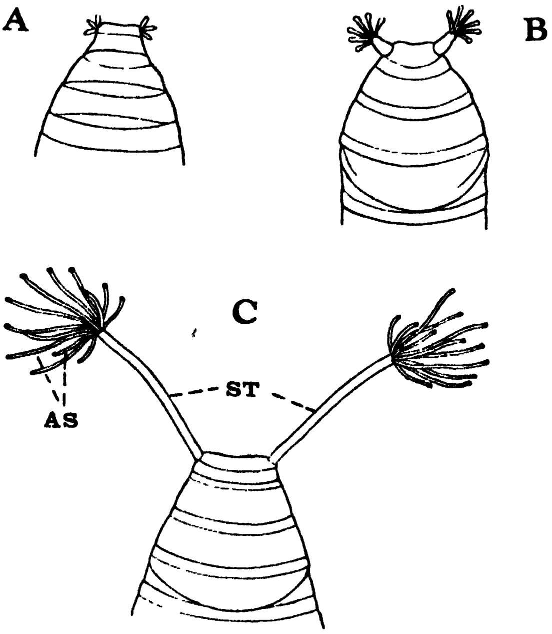

Fig. 3. Anterior parts of pupae of *Drosophila* species. A, *D. coracina*, B, *D. melanogaster*, C, *D. immigrans*. (AS=Anterior spiracles, ST=Stalk of horns).

The characteristics of the posterior spiracles and of the ventral hooklets (also the dorsal process of *D. busckii*) of the larvae are retained in the puparium. The classification according to these structures are as follows:

Key by Pupae

(1) Tip of the posterior spiracles black in color; hooklets blackish.

D. immigrans (SB=ca. 1/3; NA=ca. 15; Fig. 3 C)

Tip of the posterior spiracles, yellow or reddish yellow in color..............(2)

(2) Large branched processes on the dorsal surface of each segment from the fourth to the twelfth.

D. busckii (SB=ca. 1/15; NA=ca. 10)

No such processes ....(3)

(3) The posterior spiracles are closed at the tip.

D. coracina (No marked stalk; NA=ca. 4; Fig. 3 A), *D. melanissima* (SB=ca. 1/18; NA=ca. 10), *D. repleta* (SB=ca. 1/18; NA=ca. 16), *D. subtilis* (SB=ca. 1/40; NA=ca. 6)

The posterior spiracles are divergent at the tip.

D. ananassae (SB=ca. 1/20; NA=ca. 10), *D. auraria* (SB=ca. 1/15; NA=ca. 10), *D. bipectinata* (SB=ca. 1/15; NA=ca. 10), *D. bizonata* (SB=ca. 1/5; NA=ca. 15), *D. ficusphila* (SB=ca. 1/10; NA=ca. 12), *D. funebris* (SB=ca. 1/11; NA=ca. 20), *D. komaii* (SB=ca. 1/2; NA=ca. 18), *D. lutea* (SB=ca. 1/16; NA=ca. 6), *D. melanogaster* (SB=ca. 1/25; NA=ca. 7; Fig. 3 B), *D. montium* (SB=ca. 1/12; NA=ca. 10), *D. nigromaculata* (SB=ca. 1/12; NA=ca. 6), *D. rufa* (SB=ca. 1/16; NA=ca. 10), *D. simulans* (SB=ca. 1/25; NA=ca. 6), *D. sordidula* (SB=ca. 1/6; NA=ca. 12), *D. suzukii* (SB=ca. 1/20; NA=ca. 8), *D. takahashii* (SB=ca. 1/16; NA=ca. 8), *D. transversa* (SB=ca. 1/12; NA=ca. 10), *D. virilis* (SB=ca. 1/30; NA=ca. 15)

Species not examined: *D. grandis*, *D. histrio*, *D. nipponica*.

(5) Internal characters

(*A*) *Chromosomes*

In Plate XXVIII and the following list, are shown the female-chromosome types of *Drosophila* species which thus far have been studied by various workers. The Japanese species described in this paper are indicated by Gothic letters. The sex-chromosomes, if known, are described in the table. A detailed statement on this problem will be published elsewhere.

As pointed by many cytologists on both animals and plants, the chromosome types are very useful for distinguishing the varieties, subspecies or the closely related species. The principal references on this problem are as follows:

Dobzhansky, Th. (1935) Genetics, 20: 367–376, 377–391.
Frolowa, S. L. (1926) Zeitschr. Zellforsch., 3: 682–694.
Frolowa, S. L. (1930) *Ibid.* 10: 214–220.
Frolowa, S. L., and B. L. Astaurow (1930) *Ibid.* 10: 201–213.
Heitz, E. (1933) *Ibid.* 20: 237–287.
Katayama, H., and H. Kikkawa (1937) Jap. Journ. Genet., 13: 6–8.
Kikkawa, H. (1936) *Ibid.* 12: 137–142.
Metz, C. W., and M. S. Moses (1923) Journ. Hered., 14: 195–204.
Morgan, T. H., C. B. Bridges and A. H. Sturtevant (1925) Bibliogr. Genetica, 2: 1–262.
Sturtevant, A. H., and Th. Dobzhansky (1936) Amer. Nat., 70: 574–584.

List of types of female-chromosomes

A-type (Pl. XXVIII, A)

D. auraria Peng (X=rod, Y=small rod), *D. bromeliae* Sturtevant, *D. busckii* Coquillett, ***D. ficusphila*** *sp. nov.*, *D. florae* Sturtevant, ***D. lutea*** *sp. nov.* (X=rod, Y=small rod), *D.*

melanogaster Meigen (X=rod, Y=J-shaped), *D.* ***nebulosa*** Sturtevant, ***D. coracina*** *sp. nov.*, *D.* ***quinaria*** Loew, *D.* ***robusta*** Sturtevant, ***D. rufa*** *sp. nov.* (X=rod), ***D. saltans*** Sturtevant, ***D. simulans*** Sturtevant (X=rod, Y=small rod or J-shaped), ***D. suzukii*** (Matsumura), ***D. takahashii*** Sturtevant (X=rod, Y=small rod), *D.* ***vibrissina*** Fallén, ***Chymomyza amoena*** Loew, *C.* ***procnemis*** Williston, ***Mycodrosophila dimidiata*** Loew, ***Scaptomyza graminum*** Fallén.

B-type (Pl. XXVIII, B)
D. ***earlei*** Sturtevant, *D.* ***willistoni*** Sturtevant (X=V-shaped, Y=rod).

C-type (Pl. XXVIII, C)
D. ***calloptera*** Schiner, ***Scaptomyza adusta*** Loew.

D-type (Pl. XXVIII, D)
D. immigrans Sturtevant (X=rod), ***D. komaii*** *sp. nov.* (X=rod).

E-type (Pl. XXVIII, E)
D. ***melanica*** Sturtevant, ***D. melanissima*** Sturtevant, ***D. sordidula*** *sp. nov.* (X=V-shaped), *D.* ***trivittata*** Strobl.

F-type (Pl. XXVIII, F)
D. ***cardini*** Sturtevant, *D.* ***mulleri*** Sturtevant, *D.* ***phalerata*** Meigen (X=rod, Y=rod), *D.* ***ramsdeni*** Sturtevant, *D.* ***similis*** Williston (X=rod), ***D. transversa*** Fallén (X=rod), *D.* ***tripunctata*** Loew, ***D. virilis*** Sturtevant (X=rod, Y=rod).

G-type (Pl. XXVIII, G)
D. funebris Fabricius (X=long rod, Y=long rod), ***D. histrio*** Meigen.

H-type (Pl. XXVIII, H)
D. bizonata *sp. nov.* (X=V-shaped), ***Cladochaeta nebulosa*** Coquillett.

I-type (Pl. XXVIII, I)
D. ***hydei*** Sturtevant (X=V-shaped, Y=rod), ***D. repleta*** Wollaston (X=V-shaped, Y=rod)

J-type (Pl. XXVIII, J)
D. ***miranda*** Dobzhansky (Xs=V- and rod-shaped, Y=small V-shaped), *D.* ***pseudoobscura*** Frolowa & Astaurow (X=V-shaped, Y=various types).

K-type (Pl. XXVIII, K)
D. ***affinis*** Sturtevant (X=V-shaped, Y=J-shaped), *D.* ***algonquin*** Sturtevant & Dobzhansky (X=V-shaped, Y=J-shaped, the V-shaped autosomes of *D.* ***affinis*** are replaced with the J-shaped ones), *D.* ***athabasca*** Sturtevant & Dobzhansky (the same), *D.* ***azteca*** Sturtevant & Dobzhansky (the same).

L-type (Pl. XXVIII, L)
D. ananassae Doleschall (*D. caribbea* Sturtevant) (X=long V-shaped, Y=rod or J-shaped), ***D. bipectinata*** Duda.

M-type (Pl. XXVIII, M)
D. montium Race A de Meijere (X=rod, Y=small V-shaped).

N-type (Pl. XXVIII, N)
D. montium Race B de Meijere (X=rod, Y=small V-shaped).

O-type (Pl. XXVIII, O)
D. subtilis *sp. nov.*

P-type (Pl. XXVIII, P)
D. ***sulcata*** Sturtevant (X=large V-shaped, Y=large V-shaped).

Q-type (Pl. XXVIII, Q)
D. ***obscura*** Fallén

(*B*) *Structures of testes*

The penis of *Drosophila* is a chitinized tube, differing greatly in shape from species to species, but we have not made any detailed investigation on it. The structures of testes, however, were studied to some extent. They are usually cylindrical and coiled, but are ellipsoidal in *D. coracina*. In Figure 4 are shown several kinds of testes.

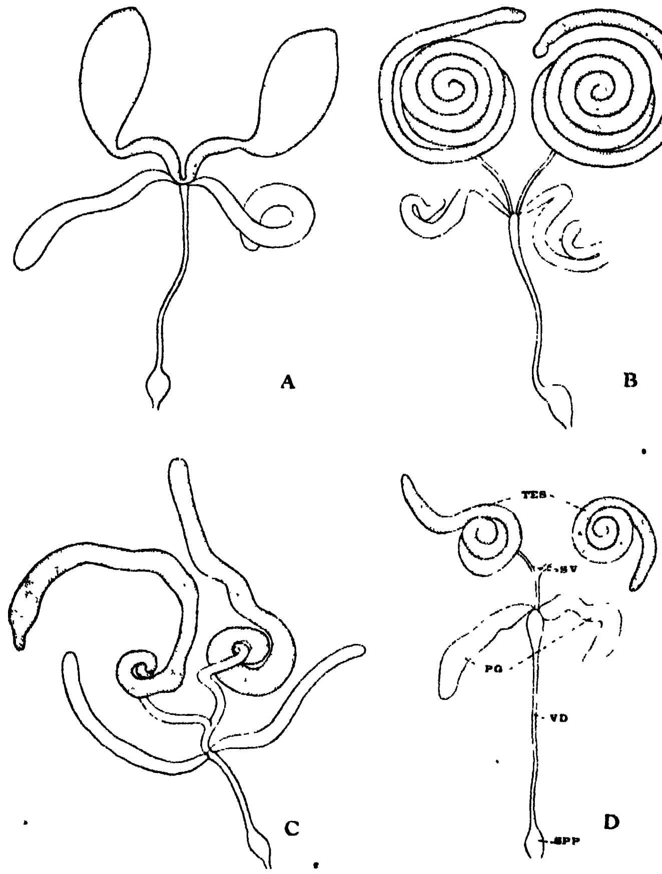

Fig. 4. Structures of testes of some species of *Drosophila*.
A, *D. coracina*, B, *D. repleta*, C, *D. subtilis*, D, *D. auraria*.
PG=Paragonia, SPP=Sperm pump, SV=Seminal vesicles, TES=Testes
VD=Vas deferens.

(*C*) *Other internal structures*

Sturtevant (1921) has investigated the forms of spermathecae of various species of Drosophilidae, and has given many useful figures (pp. 36–37). Of those figures, the following may be applicable to the Japanese species: ***D. busckii***, ***D. ananassae*** (***D. caribbea***), ***D. funebris***, ***D. immigrans***, ***D. melanogaster***, ***D. repleta***, ***D. transversa***, ***D. virilis***.

As stated before, the structures of cephalopharyngeal skeletons of third-stage larvae are extraordinarily dependable and definite specific characters (de Meijere 1915, Sturtevant 1921). But no comprehensive study has yet been made of the Japanese species.

IV. Ecological accounts

(1) Geographic distribution

Drosophila species and their habitats cleared up by the ways described in Chapter II, are shown in Plate XXIX and Table 2.

Table 2

Geographic distribution (See also Pl. XXIX)

1. Ôtomari (A, B) (T. Urita, Oct. 1935) *D. funebris*, *D. virilis*.
2. Rebun-Tô (B) (S. Emura, Aug. 1937) *D. virilis*.
3. Risiri-Tô (B) (S. Emura, Aug. 1937) *D. virilis*.
4. Tesikaga (B) (T. Komai, Sept. 1935) *D. immigrans*, *D. virilis*.
5. Akkesi (B) (Y. Haneda, July, 1934) *D. funebris*, *D. virilis*.
6. Kamikawa (B) (T. Komai, Sept. 1935) *D. virilis*.
7. Sapporo (B) (S. Makino, July 1934) *D. funebris*, *D. virilis*. (S. Makino, Sept.-Oct 1934) (Preserved in alcohol) *D. busckii*, *D. histrio*, *D. nigromaculata*, *D. sordidula*. (S. Makino, Oct. 1935) *D. nigromaculata*. (H. Kikkawa, Aug. 1937) *D. virilis*.
8. Hirosaki (B) (T. Ishihata, Aug. 1935) *D. virilis*.
9. Akita (B) (A. Seki, Oct. 1934) *D. virilis*. (A. Seki, June, 1935) *D. auraria*.
10. Innai (B) (T. Takaku, T. Itô and G. Yamamoto, Sept. 1937) *D. busckii*, *D. lutea*, *D. sordidula*, *D. virilis*.
11. Sendai (B) (S. Hozawa, June, 1935) *D. auraria*, *D. immigrans*, *D. lutea*.
12. Sado (B) (S. Watanabe, Oct. 1934) *D. immigrans*, *D. lutea*, *D. sordidula*.
13. Niigata (B) (K. Ikeda, Aug. 1934) *D. auraria*, *D. busckii*, *D. immigrans*, *D. virilis*. (K. Ikeda, Oct. 1934) *D. busckii*, *D. immigrans*, *D. lutea*, *D. virilis*. (S. Emura, Sept. 1934) *D. immigrans*, *D. virilis*.
14. Kanazawa (B) (H. Kawashima, July 1934) *D. busckii*, *D. lutea*, *D. virilis*.
15. Nagano (B) (H. Nakano, Oct. 1934) *D. lutea*.
16. Kamisuwa and adjacent localities (B) (M. Chino, various seasons, 1923–1933) *D. auraria*, *D. busckii*, *D. immigrans*, *D. lutea*, *D. melanogaster*, *D. sordidula*, *D. virilis*. (M. Shimizu, Sept. 1934) *D. immigrans*.
17. Kôhu (B) (T. Kamizawa and M. Hiraga, Sept. 1934) (Preserved in alcohol) *D. auraria*, *D. busckii*, *D. ficusphila*, *D. grandis*, *D. melanogaster*, *D. suzukii*, *D. transversa*, (*Amiota variegata*). (M. Hiraga, Dec. 1935) (Preserved in alcohol) *D. busckii*, *D. histrio*, *D. immigrans*, *D. lutea*, *D. rufa*, *D. transversa*, *D. virilis*, (*Amiota variegata*).
18. Tôkyô (B) (D. Moriwaki, July 1931) *D. ananassae*, *D. virilis*. (D. Moriwaki, Jan. 1937) (Preserved in alcohol) *D. repleta*.
19. Titizima (H) (K. Daidô, Oct. 1936) *D. melanogaster*, *D. simulans*.
20. Hahazima (H) (K. Daidô, Dec. 1936) *D. ananassae*, *D. melanogaster*, *D. simulans*.
21. Naka-Iwôtô (H) (K. Daidô, Dec. 1936) *D. ananassae*, *D. melanogaster*.
22. Gotenba (B) (T. Komai, Aug.-Sept. 1934–1937) *D. auraria*, *D. busckii*, *D. immigrans*, *D. lutea*, *D. melanogaster*, *D. sordidula*, *D. subtilis*, *D. suzukii*, *D. transversa*, *D. virilis*, (*Amiota variegata*).
23. Sizuoka and adjacent localities (B) (T. Noguti, Oct. 1936) *D. immigrans*, *D. lutea*. (H. Kobayashi, Oct. 1936) *D. lutea*, *D. melanogaster*.
24. Simoda (B) (H. Niiyama and H. Katayama, Nov. 1935) *D. coracina*, *D. immigrans*, *D. lutea*, *D. montium*. (T. Tokioka, Oct. 1936) *D. lutea*, *D. melanogaster*, *D. montium B*, *D. subtilis*.
25. Yaizu (B) (T. Teramoto, Dec. 1936) *D. immigrans*, *D. lutea*.
26. Gihu (B) (F. Ishitani, June 1935) *D. immigrans*, *D. lutea*, *D. virilis*.
27. Nagoya (B) (Y. Niwa, July 1934) *D. auraria*, *D. immigrans*.

28. Ayabe (B) (S. Kôno, July 1934) *D. auraria*, *D. virilis*. (H. Kikkawa, July 1936) *D. auraria*, *D. lutea*, *D. nigromaculata*, *D. nipponica*, *D. virilis*.
29. Kyôto (B) (M. Chino, H. Kikkawa and F. T. Peng, various seasons, 1930-1937) *D. auraria*, *D. bizonata*, *D. busckii*, *D. coracina*, *D. ficusphila*, *D. grandis*, *D. immigrans*, *D. lutea*, *D. melanissima*, *D. melanogaster*, *D. nigromaculata*, *D. rufa*, *D. sordidula*, *D. subtilis*, *D. suzukii*, *D. transversa*, *D. virilis*, (*Amiota variegata*).
30. Kitazato (B) (J. Ikari, July 1934) *D. virilis*.
31. Tu (B) (F. Ohmachi, July 1934) *D. busckii*, *D. immigrans*, *D. virilis*.
32. Kukasyô (B) (K. Higashi, July 1934) *D. auraria*, *D. immigrans*, *D. virilis*.
33. Ôsaka (B) (H. Kikkawa, Dec. 1936) *D. repleta*.
34. Sizyônawate (B) (T. Furuguchi, July 1934) *D. auraria*, *D. virilis*.
35. Nara (B) (K. Onoda, Oct. 1934) *D. melanogaster*.
36. Yuasa (B) (M. Kurisaki, Oct. 1936) *D. melanogaster*, *D. montium B*.
37. Seto (B) (I. Taki, Aug. 1926) *D. melanogaster*. (H. Kikkawa, Aug. 1932) *D. melanogaster*.
38. Katuura (B) (K. Onoda, Sept. 1934) *D. ficusphila*, *D. melanogaster*.
39. Asiya (B) (M. Tokuda, May 1935) *D. immigrans*, *D. lutea*, *D. rufa*.
40. Kôbe (B) (H. Kikkawa, June 1934) *D. auraria*, *D. immigrans*, *D. lutea*, *D. melanissima*, *D. melanogaster*, *D. subtilis*, *D. transversa*, *D. virilis*. (H. Kikkawa, Oct. 1934) *D. bizonata*, *D. transversa*.
41. Himezi (B) (R. Abe, July 1934) *D. auraria*, *D. melanogaster*, *D. virilis*.
42. Tottori (B) (S. Inomata, July 1934) *D. immigrans*, *D. virilis*.
43. Oki (B) (K. Fukushima, Oct. 1934) *D. busckii*, *D. immigrans*, *D. lutea*.
44. Kurasiki (B) (C. Harukawa, July 1934) *D. auraria*, *D. immigrans*. (C. Harukawa, Aug. 1934) *D. auraria*.
45. Hirosima (B) (S. Hareyama, July 1934) *D. immigrans*, *D. melanogaster*, *D. virilis*.
46. Tokuyama (B) (T. Hiro, July 1934) *D. busckii*, *D. immigrans*, *D. montium*, *D. virilis*.
47. Kwannonzi (B) (H. Shimizu, Aug. 1934) *D. melanogaster*.
48. Matuyama (B) (I. Taki, July 1926) *D. montium B*. (T. Ôue, May 1935) *D. auraria*, *D. immigrans*, *D. lutea*, *D. virilis*.
49. Kôti (B) (T. Kamohara, July 1934) *D. auraria*, *D. virilis*. (T. Kamohara, Oct. 1936) *D. lutea*, *D. virilis*. (T. Kamohara, Dec. 1936) *D. immigrans*, *D. virilis*.
50. Hukuoka (B) (T. Esaki, Aug. 1934) *D. melanogaster*, *D. montium*, *D. virilis*.
51. Yanagawa (B) (M. Kinoshita, July 1934) *D. melanogaster*, *D. virilis*.
52. Saga (B) (H. Fukuda, Aug. 1934) *D. virilis*.
53. Kawatana (B) (K. Hayashi, Oct. 1933) (Preserved in alcohol) *D. melanogaster*, *D. montium*.
54. Waihu (B) (K. Ishikawa, July 1934) *D. busckii*, *D. melanogaster*, *D. virilis*.
55. Ôita (B) (N. Andô, Oct. 1936) *D. immigrans*, *D. lutea*, *D. montium A.*, *D. rufa*, *D. suzukii*.
56. Kumamoto (B) (N. Takahashi, Aug. 1934) *D. melanogaster*.
57. Tomioka (B) (K. Baba, Sept. 1934) *D. melanogaster*, *D. montium A*. (K. Baba, Nov. 1936) *D. immigrans*, *D. melanogaster*, *D. montium A*.
58. Miyazaki (B) (J. Kitao, July 1934) *D. melanogaster*, *D. virilis*. (J. Kitao, Oct. 1936) *D. auraria*, *D. lutea*, *D. melanogaster*.
59. Miyanozyô (B) (T. Amase, Aug. 1937) *D. montium*, *D. virilis*.
60. Kagosima (B) (K. Hino and M. Kubo, Aug. 1934) *D. melanogaster*, *D. virilis*.
61. Sibusi (B) (T. Satô, July 1934) *D. melanogaster*.
62. Amami-Ôsima (C) (H. Ôba, June 1935) *D. busckii*. (H. Ôba, Oct. 1936) *D. ananassae*, *D. komaii*, *D. melanogaster*, *D. montium*, *D. repleta*.
63. Naha and adjacent localities (C) (D. Nakamura, March 1933) *D. repleta*. (T. Tôma, Oct. 1934) *D. ananassae*, *D. melanogaster*, *D. montium A*. (T. Tôma, Oct. 1936) *D. ananassae*, *D. melanogaster*. (K. Nakamura, July 1937) *D. ananassae*, *D. montium*.
64. Isigakizima (C) (T. Iwasaki and J. Masaki, Oct. 1934) *D. ananassae*, *D. bipectinata*, *D. komaii*, *D. montium A*. (J. Masaki, Nov. 1936), *D. melanogaster*. (K. Nakamura,

July 1937) *D. ananassae*, *D. melanogaster*, *D. repleta*.

65. Kyôzyô (D) (S. Ôta. July 1937) *D. melanogaster*.
66. Syuotu (D) (M. Tokuda, Oct. 1936) (Preserved in alcohol) *D. busckii*, *D. melanogaster*.
67. Kankô (D) (B. Nomura, July 1937) *D. virilis*.
68. Syunsen (D) (D. Sai, July 1937) *D. melanogaster*, *D. virilis*.
69. Keizyô (D) (Y. Umeya, July 1934) *D. busckii*, *D. melanogaster*, *D. montium*?, *D. sordidula*, *D. transversa*, *D. virilis*. (T. Mori, June 1935) *D. busckii*, *D. melanogaster*, *D. virilis*.
70. Port-Arthur (E) (S. Komori, Oct. 1934) *D. immigrans*, *D. melanogaster*, *D. montium*?, *D. takahashii*.
71. Taihoku (F) (Y. Horikawa, Dec. 1924) *D. repleta*. (T. Komai, Aug. 1932) *D. ananassae*, *D. bipectinata*, *D. komaii*, *D. melanogaster*. (R. Takahashi, Oct. 1934) *D. ananassae*, *D. bipectinata*, *D. komaii*, *D. melanogaster*, *D. takahashii*. (R. Takahashi, Dec. 1934) *D. ananassae*, *D. bipectinata*, *D. immigrans*, *D. melanogaster*, *D. montium A*, *D. takahashii*. (T. Shiraki, Oct. 1934) *D. ananassae*, *D. bipectinata*, *D. komaii*, *D. montium A*, *D. takahashii*. (N. Omori, Oct. 1934) *D. ananassae*, *D. bipectinata*, *D. komaii*, *D. takahashii*. (S. Aota, Oct. 1934) *D. ananassae*. (S. Aota, Dec. 1934) *D. repleta*. (M. Chino, Dec. 1934) *D. ananassae*, *D. bipectinata*, *D. immigrans*, *D. komaii*, *D. melanogaster*, *D. repleta*. (K. Koidsumi, Dec. 1934) *D. bipectinata*, *D. immigrans*, *D. komaii*, *D. melanogaster*, *D. takahashii*. (R. Takahashi, Oct. 1936) *D. bipectinata*, *D. komaii*, *D. melanogaster*, *D. takahashii*.
72. Sintiku (F) (M. Yamanaka, Nov. 1936) *D. ananassae*, *D. bipectinata*, *D. komaii*, *D. melanogaster*, *D. montium*.
73. Tainan (F) (U. Ô, Oct. 1934) *D. ananassae*. (U. Ô, Dec. 1934) *D. ananassae*, *D. melanogaster*. (U. Ô, Oct. 1936) *D. ananassae*, *D. melanogaster*.
74. Takao (F) (K. Ôta, Nov. 1936) *D. ananassae*, *D. bipectinata*, *D. melanogaster*.
75. Saipan (G) (T. Yoshino, Feb. 1937) *D. montium B*. (T. Yoshino, May 1937) *D. montium B*.
76. Palao (Pelew) (G) (F. Hiro, Oct. 1934) *D. ananassae*, *Apsinota obscuripes*. (K. Hayashi, Oct. 1935) *D. ananassae*. (T. Yamanouti, April 1937) *D. ananassae*.

Looking at the Plate XXIX and the Table 2 one may notice that *Drosophila* is widely distributed and very common in Japan and adjacent localities. There is, however, a definite range in respect to the distribution of each species, and the species so far collected may be divided into the following three categories.

(a) Cosmopolitan species:

D. busckii (Hokkaido, Hondo, Kyûsyû, Korea, Ryûkyû), *D. immigrans* (Hokkaido, Hondo, Sikoku, Kyûsyû, Kwan-tung, Formosa), *D. repleta* (Hondo, Ryûkyû, Formosa).

(b) Arctic and temperate species:

D. auraria (Hondo, Sikoku, Kyûsyû), *D. bizonata* (Hondo), *D. coracina* (Hondo), *D. ficusphila* (Hondo), *D. funebris* (Saghalien, Hokkaido), *D. grandis* (Hondo), *D. histrio* (Hokkaido, Hondo), *D. lutea* (Hondo, Sikoku, Kyûsyû), *D. melanissima* (Hondo), *D. nigromaculata* (Hokkaido, Hondo), *D. nipponica* (Hondo), *D. rufa* (Hondo, Kyûsyû), *D. sordidula* (Hokkaido, Hondo, Korea), *D. subtilis* (Hondo), *D. suzukii* (Hondo, Kyûsyû), *D. transversa* (Hondo, Korea), *D. virilis* (Saghalien, Hokkaido, Hondo, Sikoku, Kyûsyû, Korea).

(c) Tropical species:

D. ananassae (Ogasawara-Is., Ryûkyû, Formosa, Palao), *D. bipectinata*

(Ryûkyû, Formosa), *D. komaii* (Ryûkyû, Formosa), *D. melanogaster* (Hondo, Sikoku, Kyûsyû, Korea, Kwan-tung, Ryûkyû, Formosa), *D. montium* (Hondo, Kyûsyû, Korea, Kwan-tung ?), Ryûkyû, Formosa, Saipan), *D. simulans* (Ogasawara-Is.), *D. takahashii* (Kwan-tung, Formosa).

The above table indicates that there is a sharp boundary of distribution of the group, near the Ryûkyû Islands. Some species such as *D. ananassae*, *D. bipectinata* and *D. komaii* are found in Formosa and Ryûkyû, but not in Kyûsyû and other temperate zones. On the other hand, *D. virilis* is distributed from Saghalien to the southern extremity of Kyûsyû, but has not been collected from Ryûkyû and Formosa. These results remind us of the significance of the so-called Watase's line or Miyake's line. It is of interest that such a boundary is observed in the distribution of the species within the same genus. For the northern regions, however, we have been unable to reach any such definite conclusion.

Another interesting point is the manner of distribution of *Drosophila*. It is generally assumed that *Drosophila* is able to spread far away by their own power of flight. However, recent findings by Komai and Chino seem to indicate a negative conclusion. In order to investigate the problem of chromosomes or gene mutations in wild populations, they have collected many wild flies (*D. melanogaster* and *D. virilis*) from various localities, and bred them individually. The detailed statement of the subject will be published in their own papers, so that only more important points will be given here. (1) Many mutations are found especially in a heterozygous state in wild populations; (2) The same mutant may be found in the strains in different years from the same locality; (3) The same mutant is occasionally found in many strains collected at one time from the same locality. These results suggest strongly that *D. melanogaster* and *D. virilis*' are unable to spread very widely by their own power.

Besides, many mutant flies of various species escape from our laboratory, but, in contrary to our expectation, they are rarely captured in the wild of the vicinity. Thus it seems probable that accidental agencies such as typhoon or artificial means of transportation may act more important rôles than their own power of flight upon their spreading.

Mr. K. Hayashi once informed us that *D. ananassae* was very common in a ship plying between Yokohama and Palao. In fact, there is evidence that this species was introduced into Hondo from somewhere else: Professor D. Moriwaki obtained once the species from a vegetable market of Tôkyô in 1931.

(2) Food habits

In spite of the significance of the problem, little is known as to the food-habits of the group. The majority of *Drosophila* larvae are probably primarily yeast-easters as shown by several investigators (Baumberger 1917 a b, 1919, Loeb and Northrop 1916). But it is also known that some species are parasites on Ceropids and that some are occasionally found in fleshy fungi.

The Japanese species may be roughly classified by their food-habits, as follows:

Fungi: *D. bizonata, D. transversa*

Decaying fruits and sap of bleeding trees:

D. ananassae, D. auraria, D. bipectinata, D. bizonata, D. busckii, D. coracina, D. ficusphila, D. funebris, D. grandis, D. immigrans, D. komaii, D. lutea, D. melanissima, D. melanogaster, D. montium, D. nigromaculata, D. rufa, D. simulans, D. sordidula, D. subtilis, D. suzukii, D. takahashii, D. virilis.

Potatoes, excrement etc: *D. busckii, D. funebris, D. nigromaculata, D. repleta.*

Unknown: *D. histrio* (probably decaying fruits), *D. nipponica.*

Ecological studies concerning Japanese *Drosophila* have been carried out by the following investigators: Kurisaki (1925) (*D. melanogaster*), Kamizawa (1934) (*D. suzukii*), Yagi (1935) (*D. melanogaster*). Yagi states that *D. melanogaster* plays an important rôle as a carrier of Bacteria. This may be true, but judging from their habits, *D. busckii* and *D. repleta* probably take an even more important rôle than *D. melanogaster* in this respect.

V. Description of species

Subgenus *Paradrosophila* Duda 1921

Arch. f. Naturgesch., **90**: 203

(A pair of small prescutellars present)

(*1*) **Drosophila (Paradrosophila) coracina** *sp. nov.*

Imagos: ♂ ♀ Arista with about three branches above and two below. Antennae black. Front about one-third width of head, wider above; black. Second orbital about one-half size of other two. Second oral bristle about one-fourth length of first. Carina narrow and slightly flat; face blackish. A few prominent bristles on each palpus; black. Cheeks black; their greatest width about one-seventh height of eye. Eyes pilose.

Acrostichal hairs in eight rows; a pair of small prescutellars present. Mosonotum, scutellum, pleurae and legs black. Halteres white.

Abdomen black.

Wing clear; vein gray. Costal-index about 1.5; 4V-index about 2.2; 4c-index about 1.5; 5x-index about 2.0 (Pl. XXXI a).

Length body 2.0–2.2 mm; wing 2.0–2.2 mm.

Eggs: About eight filaments (Fig. 1 A). *Third larvae:* Hooklets colorless or tinged. The fully grown larvae can skip. *Pupae:* Posterior spiracles closed (Fig. 3 A). *Chromosomes:* A-type (PL. XXVIII). Testes are shown in Fig. 4 A.

Habitats: Simoda (24), Kyôto (29)

Remarks: Resembles *D. subtilis* ♂ ♀. One generation takes about 25 days at 26°C. Japanese name: *Kurotuya-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

Subgenus *Spinulophila* Duda 1924

Arch. f. Naturgesch., **90**: 203

(A series of short black spinules on the apical half of the anteroventral surface of the first femur).

(2) *Drosophila* (*Spinulophila*) *immigrans* Sturtevant 1921.

D. immigrans: Sturtevant (1921) Carnegie Inst. Wash., **301**: 83–84. Pl. III, 1; Fig. 29. (1927) Philippine Journ. Sci., **32**: 367. Peng (1937) Annot. Zool. Japon., **16**: 22–23.

D. tripunctata: Becker (1908)? Mitt. Zool. Mus. Berlin, **4**: 155. Sturtevant (1918) Bull. Amer. Mus. Nat. His., **38**: 445.

S. tripunctata: Duda (1924)? Arch. f. Naturgesch., **90**: 210; Fig. 71. (1924) Entomologiske Meddelelser, **14**: 262–265; Figs. 4, 5, 6, 7.

Imagos: ♂ Arista with about six branches above and three below. Antennae dull-brownish yellow. Front over one-third width of head; wider above; dull-brownish yellow. Second orbital one-fourth size of other two. Second oral bristle nearly as long as first. Carina slightly high; face yellowish brown. A few prominent bristles on each palpus. Cheeks yellow; their greatest width about one-third height of eye. Eyes with thick pile (Pl. XXX d).

Acrostichal hairs in eight rows: no prescutellars. Mesonotum and scutellum dull-brownish yellow. Pleurae and legs yellow. Sterno-index about 0.75. A row of about ten black bristles on lower apical part of first femur. The first and second joints of prothoracic leg shortened and thickened, with many long blackish hairs on undersurface of those joints (Fig. 5).

Abdomen dull yellow, with a posterior black band on each segment which is broadened and interrupted in mid-dorsal part. The band of last segment broader than others.

Male-hypopygium is

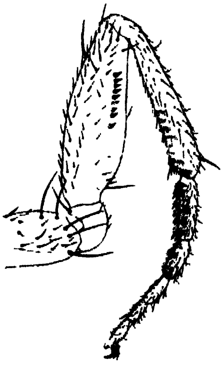

Fig. 5. Prothoracic leg of *D. immigrans* ♂. ×ca. 50.

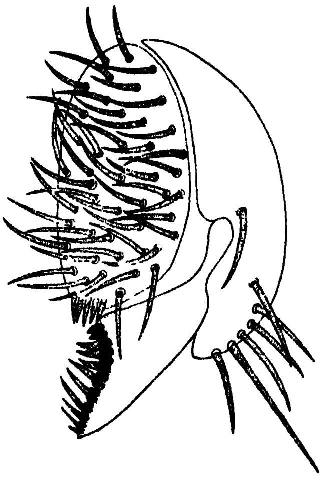

Fig. 6. Hypopygium of *D. immigrans* ♂. ×ca. 150.

shown in Fig. 6.

Wing clouded at tips of longitudinal veins, and on posterior crossveins. A single bristle at tip of first costal section (Pl. XXXI b). Costal-index about 4.5; 4V-index about 1.2; 4c-index about 0.5; 5x-index about 1.1.

Length body 3.0 mm; wing 3.0 mm.

♀ Same as above, except that the first and second tarsal joints of prothoracic leg are not shortened and thickened, and that no blackish dense hairs are found on those joints.

Eggs: Four filaments. *Third larvae:* Hooklets blackish. Tip of posterior spiracles black. *Pupae:* Posterior spiracles divergent. *Chromosomes:* D-type (Pl. XXVIII).

Habitats: Tesikaga (4), Sendai (11), Sado (12), Niigata (13), Kamisuwa (16), Kôhu (17), Gotenba (22), Sizuoka (23), Simoda (24), Yaizu (25), Gihu (26), Nagoya (27), Kyôto (29), Tu (31), Kukasyô (32), Asiya (39), Kôbe (40), Tottori (42), Oki (43), Kurasiki (44), Hirosima (45), Matuyama (48), Kôti (49), Ôita (55), Tomioka (57), Port-Arthur (70), Taihoku (71).

Remarks: Resembles *D. tripunctata* ♂ ♀ and *D. histrio* ♂ ♀. *D. immigrans* has been obtained from North America, Europe and China etc. In 1927 Sturtevant reported a variety, *formosana*, from Formosa. The variety differs from typical form only in the front tarsi, namely the short dense hairs of the two basal joints are less conspicuous than in the typical form, but there is a series of much longer recurved black hairs on the outer and anterior surfaces of all the joints of the front tarsi. We examined many specimens of *D. immigrans* collected from Formosa, but failed to find the variety. One generation takes about 12 days at 26°C. Japanese name: *O-Syôzyôbae*.

(3) *Drosophila* (*Spinulophila*) *komaii* *sp. nov.*

Imagos: ♂ (Pl. XXXII) Arista with about six branches above and three below. Antennae reddish yellow; third joint dark-brown. Front over one-third width of head, wider above: reddish yellow, with silvery glitter. Second orbital one-third size of other two. Second oral nearly as long as first. Carina broad, well developed; face reddish yellow. A few prominent bristles on each palpus. Cheeks pale; their greatest width about one-tenth height of eye. Eyes with thick pile (Pl. XXVII).

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum dull-reddish yellow. Pleurae pale yellow, with a distinct broad reddish-brown stripe which runs from propleura to the base of haltere. Sterno-index about 0.8 (Pl. XXVII). Legs yellow. A row of about ten short stout black bristles on lower apical part of the first femur (Pl. XXVII G).

Abdomen reddish yellow, with a dull-brownish band on each segment. Male-hypopygium is shown in Pl. XXVII F.

Wing slightly dusky, especially near the crossveins. Costal-index about 2.6; 4V-index about 1.8; 4c-index about 0.9; 5x-index about 1.0 (Pl. XXVII H).

Length body 2.5 mm; wing 2.0 mm.

♀ Same as above, except that there is no marked stripe on the pleurae, and that the silvery glitter on front is indistinct.

Eggs: Four filaments (Fig. 1 F). *Third larvae:* Hooklets colorless. *Pupae:* Posterior spiracles divergent. *Chromosomes:* D-type (Pl. XXVIII).

Habitats: Amami-Ôsima (62), Isigakizima (64), Taihoku (71), Sintiku (72).

Remarks: One generation takes about 12 days at 26°C. Japanese name: *Aka-Syôzyôbae*. Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

Genus *Drosophila* Fallén 1823

Dipt. Suec. Geomyz., **2**, 4.

(Typical *Drosophila*)

(4) *Drosophila ananassae* Doleschall 1858

D. ananassae: Doleschall (1858) Nat. Tijd. Ned. Ind., **17**, 128: 89. de Meijere (1908) Tijd. v. Entom., **51**: 159. (1911) *Ibid.*, **54**: 399, Fig. 40. Duda (1924) Arch. f. Naturgesch., **90**: 214. (1925) *Ibid*, **91**: 211-213, Figs. 80, 81. (1926) Supplementa Entomologica, **14**: 98. Peng (1937) Annot. Zool. Japon., **16**: 26-27.

D. caribbea: Sturtevant (1916) Ann. Ent. Soc. Amer., **9**: 335. (1921) Carnegie Inst. Wash., **301**: 92-93, Fig. 25.

D. errans: Malloch (1934)? British Mus. (Nat. Hist.) Part **6**: 301.

D. imparata: Walker (1859) Proc. Linn. Soc., **3**: 126; 164.

D. similis: Lamb (1914)? Trans. Linn. Soc., **3**: 16: 347.

Imagos: ♂ Arista with about five branches above and three below. Antennae yellow; third joint brown. Front nearly one-half width of head, wider above; yellow. Second orbital about one-half size of other two. Second oral bristle, nearly as long as first, but usually smaller than first. Carina broad and flat; face pale yellow. Only one prominent bristle on each palpus. Cheeks yellow; their greatest width about one-sixth height of eye. Eyes with thick pile.

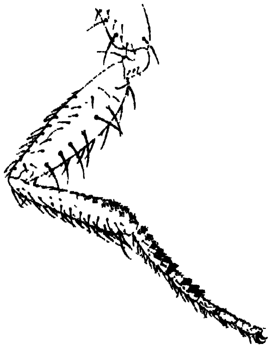
Fig. 7. Prothoracic leg of *D. ananassae* ♂. ×ca. 60.

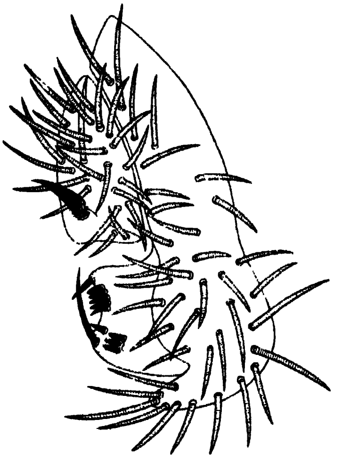
Fig. 8. Hypopygium of *D. ananassae* ♂. ×ca. 150.

Acrostichal hairs somewhat irregular, but generally in eight rows; no prescutellars. Mesonotum and scutellum reddish yellow, slightly shining. Pleurae and legs yellow. Sterno-index about 0.5. Several transverse rows of stout blackish bristles on the ventral surface of the first and second tarsal joints of prothoracic leg. These bristles become yellowish in color as they approach the base of each joint (Fig. 7).

Abdomen yellow; each segment with a dull brown posterior band. Hypopygium is shown in Fig. 8.

Wing clear; Costal-index about 1.2; 4V-index about 2.3; 4c-index about 2.0; 5x-index about 2.0 (Pl. XXXI e).

Length body 2.0–2.3 mm; wing 2.0–2.3 mm.

♀ Differs from the male in having no blackish bristles on the tarsal joints of prothoracic leg.

Eggs: Two filaments. *Third larvae:* Hooklets blackish. *Pupae:* Posterior spiracles divergent. *Chromosomes:* L-type (Pl. XXVIII).

Habitats: Tôkyô (18), Hahazima (20), Naka-Iwôtô (21), Amami-Ôsima (62), Isigakizima (64), Taihoku (71), Sintiku (72), Tainan (73), Takao (74), Palao (76).

Remarks: Resembles *D. bipectinata* ♀. According to the previous investigators, *D. ananassae* is widely distributed and very common in tropical regions (North America, Central America, South America, Java, Sumatra, New Guinea, Philippines, China etc). The genetics and cytology of this species have been reported by several investigators (Kaufmann, Kikkawa, Moriwaki, Sturtevant). One generation takes about 10 days at 26°C. Japanese name: *Ananasu-Syôzyôbae.*

(5) *Drosophila bipectinata* Duda 1923

D. bipectinata: Duda (1923) Ann. Musei Nationalis Hungarici, **20**: 52–53. (1924) Arch. f. Naturgesch., **90**: 214. (1926) Supplementa Entomologica, **14**: 98–99, Fig. 16.

Imagos: ♂ Arista with about four branches above and three below. Antennae yellow; third joint brown. Front over one-third width of head, wider above; yellow. Second orbital about one-third size of other two. Second oral nearly as long as first, but usually smaller than first. Carina broad, slightly high; face pale. Only one prominent bristle on each palpus. Cheeks yellow; their greatest width about one-eighth height of eye. Eyes with thick pile.

Acrostichal hairs somewhat irregular, but generally in eight rows; no prescutellars. Mesonotum and scutellum yellow, slightly shining. Pleurae and legs yellow. Sterno-index about 0.5. Two oblique combs of

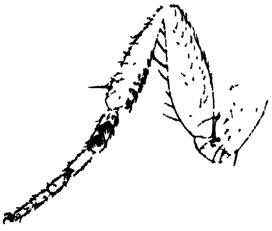

Fig. 9. Prothoracic leg of *D. bipectinata* ♂. ×ca. 50.

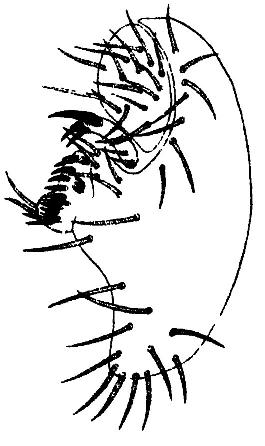

Fig. 10. Hypopygium of *D. bipectinata* ♂. ×ca. 150.

black stout bristles, on the inner surface of first tarsal joint of prothoracic leg. A few stout black bristles, on the distal part of second tarsal joint of the same leg (Fig. 9).

Abdomen yellow; each segment with a dull brown posterior band. Hypopygium is shown in Fig. 10.

Wing clear; Costal-index about 1.2; 4V-index about 2.2; 4c-index about 1.8; 5x-index about 2.0.

Length body 1.5–2.0 mm; wing 1.5–2.0 mm.

♀ Agrees with the above description, except that there is no tarsal comb.

Eggs: Two filaments. *Third larvae:* Hooklets blackish. *Pupae:* Posterior spiracles divergent. *Chromosomes:* L-type (Pl. XXVIII).

Habitats: Isigakizima (64), Taihoku (71), Sintiku (72), Takao (74).

Remarks: Resembles *D. ananassae* ♀. Duda (1924) collected this species from East Indies. One generation takes about 10 days at 26°C. Japanese name: *Hime-Syôzyôbae* (*Hutakusi-Syôzyôbae*).

(6) *Drosophila auraria* Peng 1937

D. auraria: Peng (1937) Annot. Zool. Japon., **16**: 23–24.

Imagos: ♂ Arista with about five branches above and three below. Antennae brown. Front over one-third width of head, wider above; yellow. Second orbital bristle about one-third size of other two. Second oral nearly as long as first. Carina narrow, slightly flat; face snowy white. Only one prominent bristle on each palpus. Cheeks yellow; their greatest width about one-sixth height of eye. Eyes with rather thick pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum, scutellum and pleurae shining yellow. Sterno-index about 0.5. Legs yellow. A comb of about 26 stout black bristles on the inner surface of the first tarsal joint of prothoracic leg. A similar comb of about 18 black bristles on the same surface of the second tarsal joint of prothoracic leg.

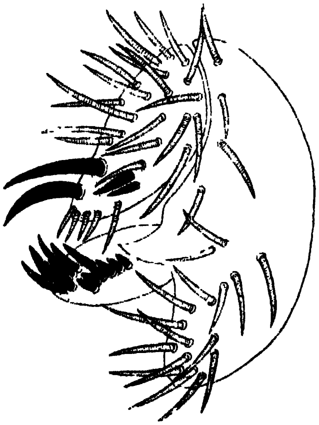

Fig. 11. Hypopygium of *D. auraria* ♂. ×ca. 150.

Abdomen shining yellow, with a blackish posterior band on each segment (the sixth segment black). Hypopygium is shown in Fig. 11.

Wing clear; Costal-index about 2.0; 4V-index about 2.7; 4c-index about 1.5; 5x-index about 2.0 (Pl. XXXI g).

Length body 2.0 mm; wing 2.0 mm.

♀ Differs from the male in having no tarsal combs, and that the face-color is pale instead of white as in the male.

Eggs: Two filaments. *Third larvae:* Hooklets blackish. *Pupae:* Posterior spiracles divergent. *Chromosomes:* A-type (Pl. XXVIII). Testes are shown in Fig. 4 D.

Habitats: Akita (9), Sendai (11), Niigata (13), Kamisuwa (16), Kôhu (17), Gotenba (22), Nagoya (27), Ayabe (28), Kyôto (29), Kukasyô (32), Sizyônawate (34), Kôbe (40), Himezi (41), Kurasiki (44), Matuyama (48), Kôti (49), Miyazaki (58).

Remarks: Resembles *D. montium* ♂ ♀, *D. nipponica* ♂ ♀, *D. rufa* ♂ ♀ and *D. ficusphila* ♂ ♀. One generation takes about 14 days at 25°C. Japanese name: *Kaoziro-Syôzyôbae.*

(7) *Drosophila rufa sp. nov.*

Imagos: ♂ Arista with about five branches above and three below. Antennae brown; third joint dark brown. Front less than one-third width of head, wider above, brownish yellow. Second orbital bristle about one-fourth size of other two. Second oral about two-thirds length of first. Carina narrow and flat; face brownish yellow. Only one prominent bristle on each palpus. Cheeks yellow; their greatest width about one-eighth height of eye. Eyes with fine pile.

Acrostichal hairs vary from six to eight in a row, but generally eight rows; no prescutellars. Mesonotum reddish yellow, shining. Scutellum brownish yellow, shining. Pleurae yellow. with a broad dark-brownish longitudinal stripe on each side. Sterno-index about 0.6. A comb of about 25 stout black bristles on the inner surface of the first tarsal joint of prothoracic leg. A similar comb of about 18 black bristles on the same surface of the second tarsal joint of prothoracic leg (Fig. 12).

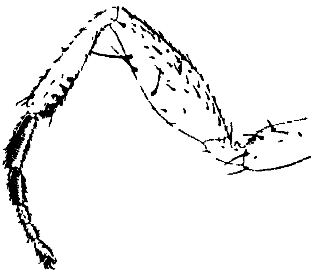

Fig. 12. Prothoracic leg of *D. rufa* ♂. ×ca. 60.

Abdomen shining yellow, with a black posterior band on each segment (2–5), but 5–6 segments almost black. Hypopygium is shown in Fig. 13.

Wing clear. Costal-index about 2.3; IV-index about 2.5; 4c-index about 1.3; 5x-index about 3.0.

Length body 2.0–2.2 mm; wing 2.0–2.2 mm.

♀ Differs from the male in having no tarsal combs and in that clypeus is brown in color instead of black as in the male.

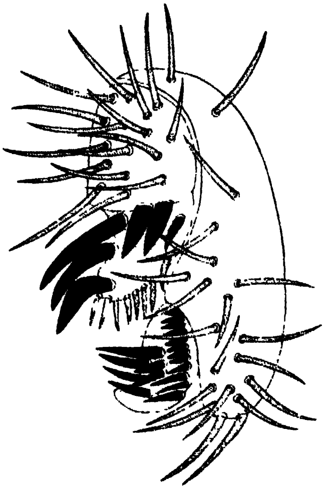

Fig. 13. Hypopygium of *D. rufa* ♂. ×ca. 150.

Eggs: Two filaments. *Third larvae:* Hooklets blackish. *Pupae:* Posterior spiracles divergent. *Chromosomes:* A-type (Pl. XXVIII).

Habitats: Kôhu (17), Kyôto (29), Asiya (39), Ôita (55).

Remarks: Resembles *D. auraria* ♂ ♀, *D. ficusphila* ♂ ♀, *D. montium* ♂ ♀ and *D. nipponica* ♂ ♀. One generation takes about 12 days at 26°C. Japanese name:

Munasuzi-Syôzyôbae. Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(8) ***Drosophila montium*** de Meijere 1916

D. montium: de Meijere (1916) Tijd. v. Entom., **59**: 205–206. Duda (1924) Arch. f. Naturgesch., **90**: 215. (1926) Supplementa Entomologica, **14**: 99, Fig. 17. Malloch (1934) British Mus. (Nat. Hist.) Part **6**: 300–301.

Imagos: Race *A* ♂ Arista with about five branches above and three below. Antennae brown; third joint dark-brown. Front more than one-third width of head, wider above; yellow. Second orbital bristle about one-third size of other two. Second oral nearly as long as first. Carina narrow and flat; face pale. Only one prominent bristle on each palpus. Cheeks yellow; their greatest width about one-seventh height of eye. Eyes with rather thick pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum, scutellum and pleurae shining yellow. Sterno-index about 0.6. Legs yellow. A comb of about 25 stout black bristles on the inner surface of the first tarsal joint of prothoracic leg. A similar comb of about 18 black bristles on the same surface of the second tarsal joint of prothoracic leg.

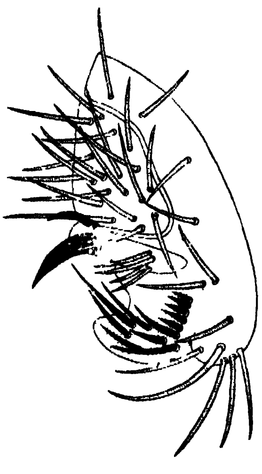

Fig. 14. Hypopygium of *D. montium* ♂. ×ca. 150.

Abdomen shining yellow, with a blackish posterior band on each segment, but the band becomes yellowish in color on the fifth and the sixth segment. Hypopygium is shown in Fig. 14.

Wing clear. Costal-index about 2.1; 4V-index about 2.5; 4c-index about 1.5; 5x-index about 2.5.

Legth body 2.0 mm; wing 2.0 mm.

♀ Differs from the male in having no tarsal combs on the tarsal joints of prothoracic leg.

Eggs: Two filaments (Fig. 1 D). *Third larvae:* Hooklets blackish. *Pupae:* Posterior spiracles divergent. *Chromosomes:* M-type (Pl. XXVIII).

Habitats: Tokuyama? (46), Hukuoka (50), Kawatana? (53), Ôita (55), Tomioka (57), Miyanozyô? (59), Amami-Ôsima (62), Naha (63), Isigakizima (64), Keizyô? (69), Port-Arthur? (70), Taihoku (71), Sintiku (72).

Race B: ♂ ♀ *Imagos, eggs, third larvae, pupae:* Agrees entirely with the above, except the cytological difference. *Chromosomes:* N-type (Pl. XXVIII).

Habitats: Simoda (24), Yuasa (36), Matuyama (48), Saipan (75).

Remarks: Resembles *D. auraria* ♂ ♀, *D. ficusphila* ♂ ♀, *D. nipponica* ♂ ♀ and *D. rufa* ♂ ♀. In 1924, Duda described two varieties of *D. montium*, *xanthopyga* and *atropyga*, from Java and Formosa respectively. The former is distinguished from the latter by the fact that the last abdominal segment is yellow in color instead of black as in the latter. The specimens thus far examined by us all belong to *xanthopyga*. But, as shown before, it is possible to classify two races from a cytological view-point (Kikkawa 1936). The records of capture suggest that this species is very common in the Oriental Region. One generation takes about 12 days at 27°C. Japanese name: *Torahu-Syôzyôbae.*

(9) *Drosophila nipponica sp. nov.*

Imagos: ♂ Arista with about five branches above and two below. Antennae brown; third joint dark-brown, with long hairs. Front over one-half width of head, wider above; yellow. Second orbital bristle very fine, about one-fifth size of other two. Second oral about one-half length of first. Carina broad and flat; face yellow. A few prominent bristles on each palpus. Cheeks yellow: their greatest width about one-fourth height of eye. Eyes with rather thick pile (Fig. 15).

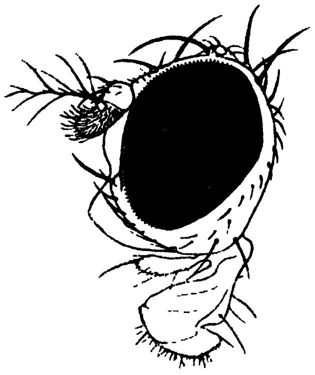

Fig. 15. Head of *D. nipponica* ♂. ×ca. 45.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum yellow. Pleurae and legs yellow; sterno-index about 0.3. A comb of about 15 stout black bristles on the inner surface of the first tarsal joint of prothoracic leg. A similar comb of about 13 black bristles on the same surface of the second tarsal joint of prothoracic leg.

Abdomen yellow, with a dark brownish posterior band on each segment, but the band becomes yellowish in color on the fifth and the sixth segment.

Wing clear. Costal-index about 2.0; 4V-index about 2.2; 4c-index about 1.1; 5x-index about 1.6.

Length body 1.8 mm; wing 1.8 mm.

♀ Differs from the male in having no tarsal combs.

Eggs, third larvae, pupae and *chromosomes* are unknown.

Habitats: Ayabe (26).

Remarks: Resembles *D. auraria* ♂ ♀, *D. ficusphila* ♂ ♀, *D. montium* ♂ ♀ and *D. rufa* ♂ ♀. Kikkawa obtained this species on leaves of clover (*Sagina maxima A.* Gray), but failed to breed on a culture-medium containing decaying fruits. Japanese name: *Yamato-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(10) *Drosophila ficusphila sp. nov.*

Imagos: ♂ Arista with about four branches above and two below. Antennae yellow; third joint brown. Front less than one-third width of head, wider above; yellow. Second orbital bristle about one-third size of other two. Second oral about three-fourth length of first. Orbital, ocellar and vertical bristles well developed. Carina narrow, flat; face yellow. Only one prominent bristle on each palpus. Cheeks yellow; their greatest width about one-seventh height of eye. Eyes with rather thick pile.

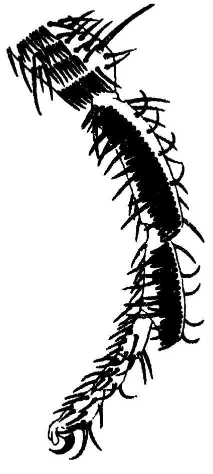

Fig. 16. Prothoracic leg of *D. ficusphila* ♂. ×ca. 180.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum reddish yellow, but brownish yellow near the base of wing. Scutellum and pleurae brownish yellow. Sterno-index about 0.8. A comb of about 25 stout black bristles on the inner surface of the first tarsal joint of prothoracic leg. A similar comb of about 18 black bristles on the same surface of second tarsal joint of prothoracic leg, which overlaps the third joint. Furthermore, several stout black bristles on each comb described above (Fig. 16).

Abdomen shining black, with a broad yellowish band on the anterior part of each segment from the first to the fourth.

Wing clear. Costal-index about 1.8; 4V-index about 2.0; 4c-index about 1.2; 5x-index about 1.5 (Pl. XXXI q).

Length body 2.2 mm; wing 2.0 mm.

♀ Differs from the male only in having no tarsal combs.

Eggs: Two filaments. *Third larvae:* Hooklets somewhat blackish. *Pupae:* Posterior spiracles divergent. *Chromosomes:* A-type (Pl. XXVIII).

Habitats: Kôhu (17), Kyôto (29), Katuura (38).

Remarks: Resembles *D. auraria* ♂ ♀, *D. montium* ♂ ♀, *D. nipponica* ♂ ♀ and *D. rufa* ♂ ♀. This species has a special fondness for the fruits belonging to the genus *Ficus* such as *F. Carica* and *F. erecta*. One generation takes about 14 days at 26°C. Japanese name: *Itiziku-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(11) *Drosophila bizonata sp. nov.*

Imagos: ♂ ♀ Arista with about five branches above and three below. Antennae brownish yellow; third joint brown. Front about one-third width of head, wider above; yellow. Second orbital bristle very fine, about one-fifth size of other two. Second oral nearly as long as first. A few prominent bristles on each palpus. Carina narrow, slightly high; face yellow. Cheeks yellow; their greatest width about one-fifth height of eye. Eyes with rather thick pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum shining yellow. Pleurae yellow; sterno-index about 0.6. Legs pale yellow.

Abdomen shining yellow, with a brownish band on the posterior part of each segment, which is interrupted in mid-dorsal part. The bands of two basal segments (occasionally three) are darker and broader than those of other segments.

Wing clear. Costal-index about 3.0; 4V-index about 1.5; 4c-index about 0.8; 5x-index about 1.2. Tips of II, III, IV longitudinal veins and the parts near the crossveins are slightly clouded (Pl. XXXI f).

Length body 2.0 mm; wing 2.0–2.2 mm.

Eggs: Four filaments. *Third larvae:* Hooklets colorless. *Pupae:* Posterior spiracles divergent. *Chromosomes:* H-type (Pl. XXVIII).

Habitats: Kyôto (29), Kôbe (40)

Remarks: One generation takes about 12 days at 26°C. Japanese name: *Hutaobi-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(12) *Drosophila lutea sp. nov.*

Imagos: ♂ Arista with about five branches above and three below. Antennae brown. Front over one-third width of head, wider above; yellow. Second orbital bristle about one-third size of other two. Second oral about two-thirds length of first. Carina narrow and flat; face yellow. Only one prominent bristle on each palpus. Cheeks yellow; their greatest width about one-tenth height of eye. Eyes pilose.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum reddish yellow, slightly shining. Pleurae yellow. Sterno-index about 0.7. Legs yellow. On the undersurface of the first tarsal joint of prothoracic leg, there are two transverse rows of about three short stout black bristles respectively. Two such rows of a few black bristles respectively on the same surface of the second tarsal joint of prothoracic leg (Fig. 17).

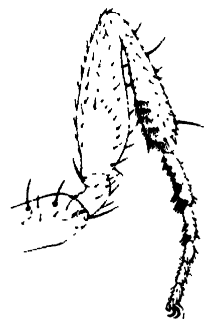

Fig. 17. Prothoracic leg of *D. lutea* ♂. ×ca. 50.

Abdomen shining black; each of the four basal segments with a basal broad yellowish band. Hypopygium is shown in Fig. 18.

Wing slightly brownish in color. Costal-index about 2.0; 4V-index about 2.2; 4c-index about 1.2; 5x-index about 2.0.

Length body 2.0–2.3 mm; wing 2.0–2.3 mm.

♀ Agrees with the above description, except that the front tarsi are plain, and that each abdominal segment has a basal broad yellowish band.

Eggs: Two filaments. *Third larvae:* Hooklets blackish. *Pupae:* Posterior spiracles divergent. *Chromosomes:* A-type (Pl. XXVIII).

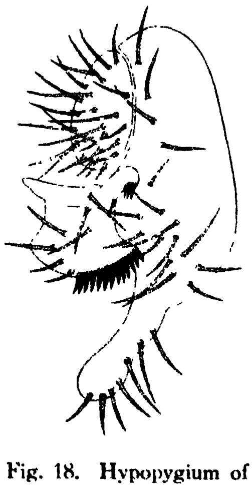

Fig. 18. Hypopygium of *D. lutea* ♂. ×ca. 150.

Habitats: Innai (10), Sendai (11), Sado (12), Niigata (13), Kanazawa (14), Nagano (15), Kamisuwa (16), Kôhu (17), Gotenba (22), Sizuoka (23), Simoda (24), Yaizu (25), Gihu (26), Ayabe (28), Kyôto (29), Asiya (39), Kôbe (40), Oki (43), Matuyama (48), Kôti (49), Ôita (55), Miyazaki (58).

Remarks: Resembles *D. melanogaster* ♀, *D.*

suzukii ♀ and especially *D. takahashii* ♂ ♀. One generation takes about 10 days at 26°C. Japanese name: *Kihada-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(*13*) ***Drosophila takahashii*** Sturtevant 1927

D. takahashii: Sturtevant (1927) Philippine Journ. Sci., **32**: 371. Peng (1937) Annot. Zool. Japon., **16**: 27.

Imagos: ♂ ♀ Agrees entirely with the descriptions of *D. lutea*, except that: (1) *D. takahashii* is smaller in size than *D. lutea*, (1.8 mm); (2) *D. lutea* has a small blackish spot in the groove located at the base of coxa of prothoracic leg; but such a spot is absent in *D. takahashii;* (3) *D. takahashii* seems to be a tropical or subtropical species, but *D. lutea* is a temperate or arctic species. *References:* Fig. 19 (Male-hypopygium); Pl. XXXI o (wing).

Eggs: (Fig. 1 B), *larvae, pupae* and *chromosomes* accord entirely with those of D. *lutea.*

Habitats: Port-Arthur (70), Taihoku (71).

Remarks: Resembles *D. melanogaster* ♀, *D. suzukii* ♀ and especially *D. lutea* ♂ ♀. One generation takes about 10 days at 26°C. Japanese name: *Takahasi-Syôzyôbae.*

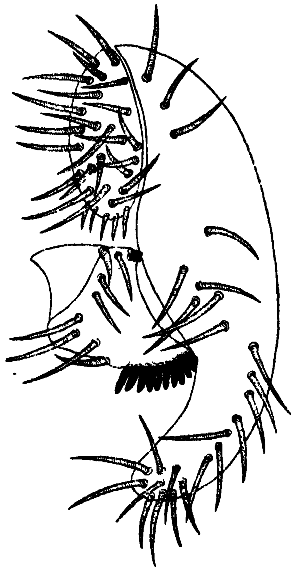

Fig. 19. Hypopygium of *D. takahashii* ♂. ×ca. 160.

(*14*) ***Drosophila melanogaster*** Meigen 1830

D. melanogaster: Meigen (1830) Syst. Beschr., **6**: 85. Sturtevant (1921) Carnegie Inst. Wash., **301**: 89–91, Figs. 2, 8, 11, 13, 31, 45; PL. III 2. Kurisaki (1925) Represajo de la Bulteno Scienca de la Fakultato Terkultura. **1**: 274–284. Esaki (1932) Nippon Konchû Zukan: 28, Fig. 47. Strasburger (1935) Berlin Verlag v. Julius Springer: 1–60. Peng (1937) Annot. Zool. Japon., **16**: 25–27.

D. ampelophila: Loew (1862) Berlin Ent. Zeit., **6**: 231. Duda (1924) Arch. f. Naturgesch., **90**: 214, Fig. 82. (1924) Entomologiske Meddelelser, **14**: 280–285, Figs. 17, 18, 19. (1925) Arch. f. Naturgesch., **91**: 147. Malloch (1934) British Mus. (Nat. Hist.) Part **6**: 300.

Described species assumed to be synonymous with *D. melanogaster. D. fasciata* Meigen (1830), *D. nigriventris* Zetterstedt (1847), *D. melanogaster* Schiner (1864), *D. uvarum* Rondani (1875), *D. pilosula* Becker (1908).

Imagos: ♂ Arista with about five branches above and three below. Antennae yellow. Front nearly one-half width of head, wider above; yellow. Second orbital bristle one-third size of other two. Second oral nearly as long as first. Carina broad and flat; face yellow. A few prominent bristles on each palpus. Cheeks yellow; their greatest width about one-fourth height of eye. Eyes with rather thick pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum reddish yellow, shining. Pleurae and legs pale yellow. Sterno-index about 0.5. A comb of about 10 stout black bristles on the inner distal surface of the first tarsal joint of prothoracic leg in oblique direction (Fig. 20).

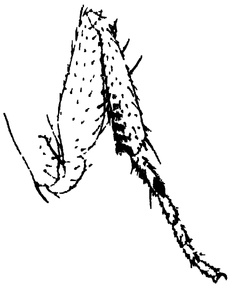

Fig. 20. Prothoracic leg of *D. melanogaster* ♂. × ca. 60.

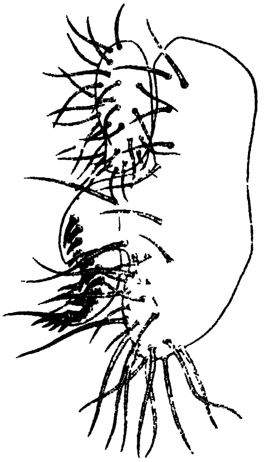

Fig. 21. Hypopygium of *D. melanogaster* ♂. × ca. 150.

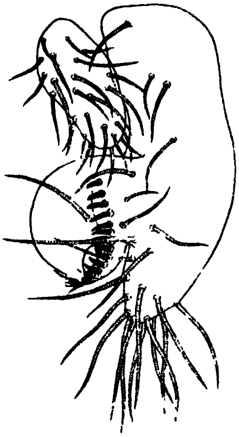

Fig. 22. Hypopygium of *D. simulans* ♂. × ca. 150.

Abdomen shining black, with a basal reddish yellow band on each of the basal four segments. Hypopygium is shown in Fig. 21.

Wing clear. Costal-index about 2.2; 4V-index about 2.4; 4c-index about 1.5; 5x-index about 2.1 (Pl. XXXI n).

Length body 2.0–2.2 mm; wing 2.0–2.2 mm.

♀ Differs from the male in having no tarsal comb and in having a basal reddish-yellow band also on the fifth and sixth abdominal segment.

Eggs: Two filaments (Fig. 1 C). *Third larvae:* Hooklets blackish (Pl. XXX a b, Fig. 2). *Pupae:* Posterior spiracles divergent (Fig. 3 B). *Chromosomes:* A-type (Pl. XXVIII).

Habitats: Kamisuwa (16), Kôhu (17), Titizima (19), Hahazima (20), Naka-Iwôtô (21), Gotenba (22), Sizuoka (23), Simoda (24), Kyôto (29), Nara (35), Yuasa (36), Seto (37), Katuura (38), Kôbe (40), Himezi (41), Hirosima (45), Kwannonzi (47), Hukuoka (50), Yanagawa (51), Kawatana (53), Waihu (54), Kumamoto (56), Tomioka (57), Miyazaki (58), Kagosima (60), Sibusi (61), Amami-Ôsima (62), Naha (63), Isigakizima (64), Kyôzyô (65), Syuotu (66), Syunsen (68), Keizyô (69), Port-Arthur (70), Taihoku (71), Sintiku (72), Takao (74).

Remarks: Resembles *D. lutea* ♀, *D. suzukii* ♀, *D. takahashii* ♀ and especially *D. simulans* ♂ ♀. *D. melanogaster* is widely distributed and very common all over the world. It is well known that this species is used under this name as a favourable material for genetical, cytological and other biological studies. However, most taxonomists argue that the name *D. ampelophila* is to be used for this species. In order to avoid confusion, we may adopt the name *D. melanogaster* in this paper. One generation takes about 10 days at 26°C. Japanese name: *Nami-Syôzyôbae*, (*Syôzyôbae*, *Kiiro-Syôzyôbae*).

(*15*) ***Drosophila simulans*** Sturtevant 1919

D. simulans: Sturtevant (1919) Psyche 26: 153. (1921) Carnegie Inst. Wash., **301**: 91, Figs. 5, 15, 46; Pl. I 5.

Imagos: ♂ ♀ No constant differences from *D. melanogaster*, except that: the eye is larger than that of *melanogaster*, and that the shape of clasper and of the posterior process of the hypopygium of male, are distinct (Fig. 22).

Eggs, third larvae, pupae and *chromosomes:* Nearly same as of *D. melanogaster.*

Habitats: Titizima (19), Hahazima (20).

Remarks: Resembles *D. lutea* ♀, *D. suzukii* ♀, *D. takahashii* ♀ and especially *D. melanogaster* ♂ ♀. *D. simulans* was first collected from the Eastern States of North America, but recently it is known that this species is distributed not only in North America, but also in Europe, Australia and now in Asia. Japanese name: *Onazi-Syôzyôbae.*

(*16*) ***Drosophila suzukii*** (Matsumura) Kamizawa 1931

Leucophenga suzukii: Matsumura (1931) Illustrated Insects of Japan Empire: 366, Fig. 158.

D. suzukii Kamizawa (1934) Report of Yamanasi Agricul. Exp. Station, 1: 1-24, 2 Pls. Peng (1937) Annot. Zool. Japan., **16**: 21-22.

Imagos: ♂ (Pl. XXXII) Arista with about five branches above and three below. Antennae yellow; third joint yellowish brown. Front about one-third width of head, wider above; yellow: Second orbital bristle about one-half size of other two, and situated nearly in the middle between the other two, Second oral nearly as long as first. Only one prominent bristle on each palpus. Carina narrow and high; face yellow. Cheeks pale yellow; their greatest width about one-sixth height of eye. Eyes with rather thick pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum, scutellum and pleurae yellow, slightly shining. Sterno-index about 0.7. Legs yellow. A comb of about four black short stout bristles on the inner distal surface of the first tarsal joint of prothoracic leg. A similar comb of a few black bristles on the same surface of the second tarsal joint of prothoracic leg (Fig. 23).

Abdomen shining black, with a broad yellowish basal band on each of the basal four segments.

Wing hyaline. A blackish spot at tip of the second longitudinal vein. Costal-index about 4.0; 4V-index about 2.2; 4c-index about 0.8; 5x-index about 1.6 (Pl. XXXI 1).

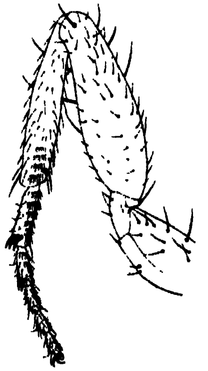

Fig. 23. Prothoracic leg of *D. suzukii* ♂. ×ca. 50.

Length body 2.0–2.2 mm ; wing 2.0–2.2 mm.

♀ Differs from the male in having no tarsal combs and in that each segment has a basal yellowish band, and also in that the blackish spot in wing is very indistinct. The egg-guides well developed upward.

Eggs: Two filaments. *Third larvae:* Hooklets blackish. *Pupae:* Posterior spiracles divergent. *Chromosomes:* A-type (Pl. XXVIII).

Habitats: Kôhu (17), Gotenba (22), Kyôto (29), Ôita (55).

Remarks: Resembles *D. lutea* ♀, *D. melanogaster* ♀, *D. simulans* ♀ and *D. takahashii* ♀. Kamizawa (1934) published an extensive paper concerning the ecological study of this species. Peng obtained this species from Sanhu of China in 1935. One generation takes about 12 days at 26°C. Japanese name: *Ôtô-Syôzyôbae* (*Tumaguro-Syôzyôbae*).

(*17*) **Drosophila nigromaculata** *sp. nov.*

Imagos: ♂ ♀ Arista with about five branches above and three below. Antennae brownish yellow. Front about one-half width of head, wider above; brownish yellow. Second orbital bristle about one-fourth size of other two. Second oral about three-fourths length of first. Carina broad and high: face yellow. Only one prominent bristle on each palous. Cheeks yellow; their greatest width about one-fourth height of eye. Eyes with rather thick pile.

Acrostichal hairs in six rows: no prescutellars. Mesonotum and scutellum brownish yellow, shining. Pleurae yellow, sterno-index about 0.7. Legs yellow. Many long hairs which stand erect on the tarsal joints of prothoracic leg.

Abdomen shining yellow, with four triangular black spots on each segment from the second to the fifth. Only two spots on the sixth segment. There is also a blackish spot on the lateral margin of each dorso-lateral plate, except the last segment.

Wing yellowish in color. Tip of the third longitudinal vein and parts of crossveins are clouded; dark brown. Costal-index about 3.2; 4V-index about 1.4; 4c-index about 0.7; 5x-index about 0.9 (Pl. XXXI d).

Length body 3.0 mm; wing 3.0 mm.

Eggs, larvae: Unknown, but judging from the structure of pupae, hooklets of the larvae should be colorless. *Pupae:* Posterior spiracles divergent. *Chromosomes:* Unknown.

Habitats: Sapporo (7), Ayabe (28), Kyôto (29).

Remarks: Somewhat resembles *D. transversa* ♂ ♀. Japanese name: *Ô-hosi-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(*18*) **Drosophila transversa** Fallén 1823

D. transversa: Fallén (1823) Diot. Suec. Geomyz., **2**: 6. Sturtevant (1921) Carnegie Inst. Wash., **301**: 81, Fig. 40; Pl. I 7. Duda (1924) Entomologiske Meddelelser, **14**: 291–293, Fig. 24. (1924) Arch. f. Naturgesch., **90**: 218, Fig. 89.

Imagos: ♂ ♀ Arista with about five branches above and three below. Antennae yellowish brown. Front about one-half width of head, wider above;

reddish yellow. Second orbital bristle very fine, about one-fifth size of other two. Second oral one-half length of first; other oral bristles very fine and short. Carina broad and flat; face yellow. A few prominent bristles on each palpus. Cheeks yellow; their greatest width about one-third height of eye. Eyes with rather fine pile.

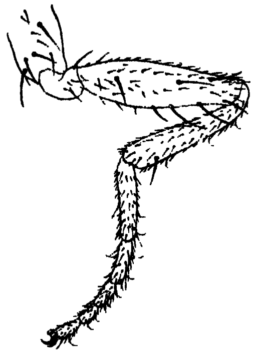

Fig. 24 Prothoracic leg of *D. transversa* ♂. ×ca. 50.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum reddish yellow, shining. Pleurae and legs yellow. Sterno-index about 0.6. Many long hairs which stand erect on the tarsal joints of prothoracic leg (Fig. 24).

Abdomen shining yellow, with four black triangular spots on each segment from the second to the fifth, but the number of these spots varies from two to four on the fourth and fifth segments.

Wing clouded at the tip of III and IV longitudinal veins and on each crossvein. Costal-index about 3.0; 4V-index about 1.5; 4c-index about 0.9; 5x-index about 1.2.

Length body 2.2–2.5 mm; wing 2.2–2.5 mm.

Eggs: Three filaments; median one is thicker than the others (Fig. 1 E). *Third larvae:* Hooklets colorless. *Pupae:* Posterior spiracles divergent. *Chromosomes:* F-type (Pl. XXVIII).

Habitats: Kôhu (17), Gotenba (22), Kyôto (29), Kôbe (40), Keizyô (69).

Remarks: Resembles *D. nigromaculata* ♂ ♀. In respect to the structure of imago alone, the specimens examined resemble rather *D. quinaria* Loew than *D. transversa* Fallén. But the structures of eggs and of chromosome types indicate that the species differs clearly from *D. quinaria*. Therefore, the name *D. transversa* is used here, but we have no conviction as to this identification. One generation takes about 12 days at 26°C. Japanese name: *Hosi-Syôzyôbae.*

(19) *Drosophila melanissima* Sturtevant 1916

D. melanissima: Sturtevant (1916) Ann. Ent. Soc. Amer., **9**: 333. (1921) Carnegie Inst. Wash., **301**: 95.

Imagos: ♂ Arista with about four branches above and two below. Antennae black brown. Front about one-third width of head, wider above; blackish. Second orbital bristle about one-third size of other two. The ratio of the second oral bristle to the first irregular, but usually less than 1.0. Carina broad and flat; face black. A few prominent bristles on each palpus. Cheeks dark brown; their greatest width about one-fourth height of eye. Eyes with short thick black pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum, scutellum and pleurae blackish brown. Sterno-index about 0.9. Legs brown.

Abdomen black with a narrow brownish anterior band on each segment.

Wing slightly brownish. Costal-index about 2.2; 4V-index about 2.0; 4cindex about 1.1; 5x-index about 1.0 (Pl. XXXI j).

Length body 2.3 mm; wing 2.3 mm.

♀ Agrees with the above description except that the basal bands of abdominal segments are broader and more yellowish in color. These bands project into the posterior region in the middle and lateral parts, especially in old females.

Eggs: Two filaments. *Third larvae:* Hooklets colorless. *Pupae:* Posterior spiracles closed. *Chromosomes:* E-type (Pl. XXXVIII).

Habitats: Kyôto (29), Kôbe (40).

Remarks: Examining the species, it was found that this species resembles very closely both *D. melanica* Sturtevant and *D. melanissima* Sturtevant. But, as the result of crossing with *D. melanica* which was sent by Prof. W. P. Spencer from the North America, it was proved that they were not identical species. Therefore, the name *D. melanissima* is used here, but we have no conviction as to this identification. One generation takes about 12 days at 26°C. Japanese name: *Karasu-Syôzyôbae.*

(20) *Drosophila sordidula sp. nov.*

Imagos: ♂ ♀ Arista with about five branches above and two below. Antennae black. Front about two-fifths width of head, wider above; dark brown. Second orbital bristle about one-third size of other two. Only one prominent oral bristle. Carina broad and flat; face brown. A few prominent bristles on each palpus. Cheeks brown; their greatest width about one-fifth height of eye. Eyes pilose.

Acrostichal hairs irregular in row, varying from six to eight; no prescutellars. Mesonotum dull blackish brown, with four indistinct brownish stripes on the anterior parts. Scutellum and pleurae blackish-brown. Sterno-index about 0.7. Legs brown.

Abdomen brown, with a broad blackish band on each segment. Hypopygium is shown in Fig. 25.

Wing somewhat dusky. Costal-index about 3.2; 4V-index about 1.8; 4c-index about 0.7; 5x-index about 1.0 (Pl. XXXI h).

Length body 3.0 mm; wing 3.0 mm.

Eggs: Four filaments. *Third larvae:* Hooklets colorless. *Pupae:* Posterior spiracles divergent. *Chromosomes:* E-type (Pl. XXVIII).

Habitats: Sapporo (7), Akita (9), Innai (10), Sado (12), Kamisuwa (16), Gotenba (22), Kyôto (29), Keizyô (69).

Remarks: *D. sordidula* resembles closely *D. sulcata* Sturtevant ♂ ♀. But, by crossing method, it was found that they were not identical species. One generation takes about 16 days

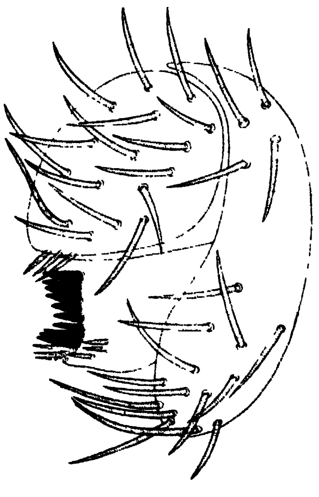

Fig. 25. Hypopygium of *D. sordidula* ♂. ×ca. 150.

at 26°C. Japanese name: *Ô-Kuro-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(21) *Drosophila virilis* Sturtevant 1916

D. virilis: Sturtevant (1916) Ann. Ent. Soc. Amer., **9**: 330. (1921) Carnegie Inst. Wash., **301**: 97, Figs. 12, 42, 48. Esaki (1932) Nippon Konchû Zukan: 28, Fig. 48. Peng (1937) Annot. Zool. Japon., **16**: 22–23.

D. nigrifemur: Duda (1926) Arch. f. Naturgesch., **91**: 192–193.

Imagos: ♂ (Pl. XXXII) ♀ Arista with about five branches above and two below. Antennae brown; third joint dark-brown. Front over one-third width of head, wider above; brown. Second orbital bristle one-third size of other two. Second oral one-half length of first. Only one prominent bristle on each palpus. Carina broad and high; face brown, slightly shining. Cheeks yellowish brown; their greatest width about one-third height of eye. Eyes pilose.

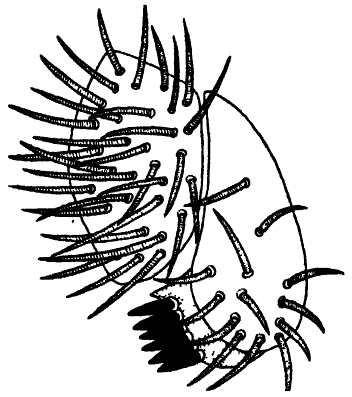

Fig. 26. Hypopygium of *D. virilis* ♂. ×ca. 150.

Acrostichal hairs in six rows; no prescutellars. Mesonotum dull brown with four indistinct dark-brown longitudinal stripes. Scutellum, pleurae dark dull brown. Sterno-index about 0.9. Legs pale brown. In male, there are many long brownish hairs which stand erect on the tarsal joints of prothoracic leg.

Abdomen dark brown. Hypopygium is shown in Fig. 26.

Wing clear. Costal-index about 2.5; IV-index about 1.8; 4c-index about 1.0; 5x-index about 1.0 (Pl. XXXI k).

Length body 2.5–3.0 mm; wing 2.5–3.0 mm.

Eggs: Four filaments. *Third larvae:* Hooklets colorless. *Pupae:* Posterior spiracles divergent. *Chromosomes:* F-type (Pl. XXVIII).

Habitats: Ôtomari (1), Rebun-Tô (2), Risiri-Tô (3), Tesikaga (4), Akkesi (5), Kamikawa (6), Sapporo (7), Hirosaki (8), Akita (9), Innai (10), Niigata (13), Kanâzawa (14), Kamisuwa (16), Kôhu (17), Tôkyô (18), Gotenba (22), Gihu (26), Ayabe (28), Kyôto (29), Kitazato (30), Tu (31), Kukasyô (32), Sizyônawate (34), Kôbe (40), Himezi (41), Tottori (42), Hirosima (45), Tokuyama (46), Matuyama (48), Kôti (49), Hukuoka (50), Yanagawa (51), Saga (52), Waihu (54), Miyazaki (58), Miyanozyô (59), Kagosima (60), Kankô (67), Syunsen (68), Keizyô (69).

Remarks: This species is widely distributed and common in the eastern Palaearctic regions, but very rare in the Nearctic regions. As pointed out by Sturtevant (1921), the occurrence of *D. virilis* in North America may be due to importation. Though no extensive study has yet been performed, the Japanese form is somewhat different from the American; namely, the former is longer than the latter in both the length of body and of wing. The genetics of this species has been carried out largely by several investigators (Chino, Demerec, Fujii, Kikkawa, Metz, Weinstein etc). One generation takes about 14 days at 26°C. Japanese name: *Kuro-Syôzyôbae.*

(22) ***Drosophila subtilis sp. nov.***

Imagos: ♂ ♀ (Pl. XXXII) **Arista with about four branches above and two below.** Antennae dark brown; third joint blackish. Front over one-third width of head, slightly wider above; brown. Second orbital bristle two-thirds length of third, and one-half length of first. Orbital, ocellar and vertical bristles well developed. Second oral about one-half length of first, sometimes only one prominent oral bristle. Carina narrow and flat; face dark brown. A few prominent bristles on each palpus. Cheeks pale brown; their greatest width about one-fourth height of eye. Eyes pilose (Pl. XXX c).

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum shining dark brown; with a whitish spot on each shoulder. Four indistinct brownish stripes on mesonotum. Pleurae brown with an indistinct dark brownish stripe on each side. Sterno-index about 0.9. Legs brown.

Abdomen dark brown, shining.

Wing dusky, pointed at the tip. Costal-index about 1.8; 4V-index about 2.2; 4c-index about 1.3; 5x-index about 1.3.

Length body 2.0 mm; wing 2.0 mm.

Eggs: Four filaments. In general, they are split into two or three at the tip. *Third larvae:* Hooklets blackish. The fully grown larvae can skip. *Pupae:* Posterior spiracles elongated and closed. *Chromosomes:* O-type (Pl. XXVIII). Testes are shown in Fig. 4 C.

Habitats: Gotenba (22), Simoda (24), Kyôto (29), Kôbe (40).

Remarks: Resembles *D. coracina* ♂ ♀. One generation takes about 20 days at 25°C. Japanese name: *Susubane-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(23) ***Drosophila busckii*** Coquillett 1901

D. busckii: Coquillett (1901) Ent. News, **12**: 18. Sturtevant (1921) Carnegie Inst. Wash., **301**: 77, Fig. 24; Pl. II 2. Duda (1924) Arch. f. Naturgesch., **90**: 221, Fig. 95. (1924) Entomologiske Meddelelser, **14**: 301–302, Fig. 29. Peng (1937) Annot. Zool. Japon., **16**: 21–25.

D. rubrostriata: Becker (1908) Mitt. Zool. Mus., 4.

D. plurilineata: Villeneuve (1911) Wien. Ent. Zeit., **30**.

Imagos: ♂ ♀ Arista with about six branches above and two below. Antennae yellow; third joint dark brown. Front over one-half width of head, wider above; yellow. Second orbital bristle nearly as long as third which is about three-fourths length of first. Second oral nearly as long as first. Only one prominent bristle on each palpus. Carina high and slightly flat; face whitish. Cheeks whitish; their greatest width about one-third height of eye. Eyes with rather thick pile (Fig. 27).

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum yellow, with five dark brownish stripes on the mesonotum; one median stripe being bifid behind and divergent into two branches at the parts of dorsocentral bristles; one in each dorsocentral line, does not reach the anterior margin of thorax; one in each outer scutellar line, less dark and arises near the region of anterior dorsocentral bristle. There is also a stripe running from just above the humerus to just above the wing. Pleurae pale yellow, with three dark brownish stripes on each side; one present below the humerus; one long stripe runs across the mesopleurae, halteres and the margin of each dorsolateral plate. There is also a stripe formed by three blackish spots; two on sternopleura, one on hypopleura. Sterno-index about 0.3. Legs yellow. Apical bristles on first and second tibiae, preapicals evident only on third.

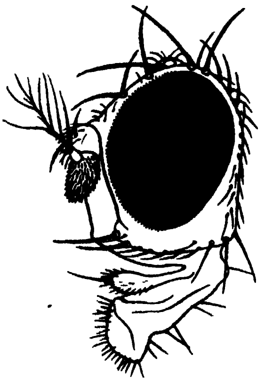

Fig. 27. Head of *D. busckii*. ×ca. 45.

Abdomen yellow, each segment with an apical black band that is interrupted in the mid-dorsal line, and attenuated or interrupted between that line and each lateral margin of abdomen.

Wing clear. Costal-index about 3.0; 4V-index about 2.2; 4c-index about 1.0; 5x-index about 2.0.

Length body 2.0-2.2 mm; wing 2.2-3.0 mm.

Eggs: Four filaments. *Third larvae:* The larva of this species bears on the dorsal surface of each segment from the fourth to the twelfth, about six branched processes. *Pupae:* Special processes on the dorsal surface may be of great use for distinguishing this species. *Chromosomes:* A-type (Pl. XXVIII).

Habitats: Sapporo (7), Innai (10), Niigata (13), Kanazawa (14), Kamisuwa (16), Kôhu (17), Gotenba (22), Kyôto (29), Tu (31), Oki (43), Tokuyama (46), Waihu (54), Amami-Ôsima (62), Syuotu (66), Keizyô (69).

Remarks: This is one of the cosmopolitan species and is widely distributed in Europe, North America, South America etc. The genetics of *D. busckii* has been carried out by Warren (1920, Genetics 5: 60-110). One generation takes about 14 days at 26°C. Japanese name: *Hyômon-Syôzyôbae.*

(24) *Drosophila funebris* Fabricius 1787

D. funebris: Fabricius (1787) Mant. Ens., **2**, 345, 33 (as *Musca*). Sturtevant (1921) Carnegie Inst. Wash., **301**: 84-86, Figs. 1, 3, 7, 16, 27; Pl. II 3. Duda (1924) Entomologiske Meddelelser, **14**: 278-280, Figs. 15, 16. (1925) Arch. f. Naturgesch., **91**: 147. Matsumura (1931) Illustrated insects of Japan Empire, 367, Fig. 157.

Musca erythrophthalma: Panzer (1794) Fauna Germ., 17: 24. Not *D. funebris* Meigen (1830).

Imagos: ♂ ♀ Arista with about six branches above and four below. Antennae yellow; third joint brown. Front about one-half width of head, wider above; yellowish brown. Second orbital bristle about two-thirds length of third, and one-half length of first. A few prominent bristles on each palpus. Carina broad and flat; face yellowish brown. Cheeks yellowish brown; their greatest width about one-third height of eye. Eyes with thick pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum slightly shining, reddish brown. Sterno-index about 0.7. Pleurae yellow brown above, becoming yellow below. Legs yellow.

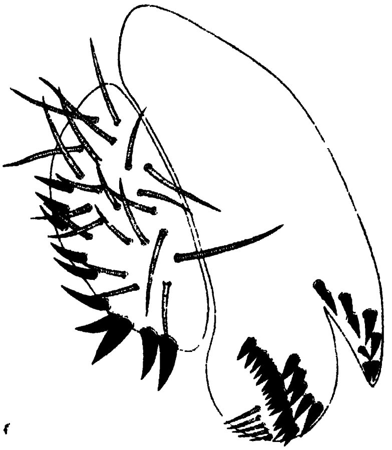

Fig. 28. Hypopygium of *D. funebris* ♂. ×ca. 150.

Abdomen, in the male, shining black; basal four segments usually interrupted by yellowish brown bands in the mid-dorsal part. In the female, each segment has an anterior yellowish band. Hypopygium of the male is shown in Fig. 28.

Wing clear; vein brown. Costal-index about 3.5; 4V-index about 1.5; 4c-index about 0.7; 5x-index about 1.0.

Length body 2.5–3.0 mm; wing 2.5–3.0 mm.

Eggs: Four filaments. *Third larvae:* Hooklets colorless. *Pupae:* Posterior spiracles divergent. *Chromosomes:* G-type (Pl. XXVIII).

Habitats: Ôtomari (1), Akkesi (5), Sapporo (7).

Remarks: The body-color of young imago of this species is very light as compared with that of an old one. This species is one of the cosmopolitan species and found commonly in north districts of palaearctic and nearctic regions. The genetics of the species has been reported by several investigators (Spencer, Timoféeff-Ressovsky). One generation takes about 15 days at 26°C. Japanese name: *Suzi-Syôzyôbae* (*Tobiiro-Syôzyôbae*).

(25) *Drosophila grandis* *sp. nov.*

Imagos: ♂ Arista with about three branches above and two below. Antennae brown. Front over one-third width of head, wider above; pale yellow, with two dark brown longitudinal stripes. Second orbital bristle about one-third size of other two. Only one prominent oral bristle. A few prominent bristles on each palpus. Carina broad and flat, well developed; face pale yellow. Cheeks blackish with slightly glitter; their greatest width about one-fourth height of eye. Eyes with thick pile. Proboscis yellow, blackish brown at the tip.

Acrostichal hairs in six rows; no prescutellars. Mesonotum reddish brown, with two yellowish stripes on both sides of each dorsocentral row. Scutellum reddish brown; its margin yellow. Pleurae black. Sterno-index about 0.6. Legs brownish yellow. Coxa of prothoracic leg blackish.

Abdomen dark dull brown, with yellowish areas on lateral side of each segment from the second to the fifth.

Wing clear. Costal-index about 2.0; 4V-index about 1.2; 4c-index about 1.0; 5x-index about 1.1. The first longitudinal vein blackish at the base (Pl. XXXI c).

Length body 4.0 mm; wing 3.5 mm.

♀ Differs from the male in the following points: (1) Cheeks yellow except bucca; (2) Coxa of prothoracic leg yellow; (3) Pleurae yellow, with three dark brownish longitudinal stripes on each side.

Eggs: Four long filaments. *Larvae, pupae, chromosomes:* Unknown.

Habitats: Kọhu (17), Kyôto (29).

Remarks: Japanese name: *Munaguro-Syôzyôbae.* Cotypes are preserved in Zool. Inst., Kyôto Imp. Univ., Kyôto, Japan.

(26) ***Drosophila histrio*** Meigen 1830

D. histrio: Meigen (1830) Syst. Beschr., **6.** Duda (1924) Arch. f. Naturgesch., **90:** 217, Fig. 87. (1924) Entomologiske Meddelelser, **14:** 285, Fig. 20.

Not *D. histrio* Schiner (1864) *D. histrio* Oldenberg (1914).

Imagos: ♂ ♀ Arista with about five branches above and three below. Antennae brownish yellow. Front about one-third width of head, wider above; yellow. Second orbital very fine, about one-fifth length of other two. Second oral about three-fourths length of first. A few prominent bristles on each palpus. Carina broad and flat; face yellow. Cheeks yellow; their greatest width about one-fifth height of eye. Eyes with rather thick pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum reddish yellow, shining. Pleurae yellow. Sterno-index about 0.6. Legs yellow.

Abdomen yellow, with a dark brownish posterior band on each segment from the first to the fourth, which is interrupted in the mid-dorsal part. These bands become narrow and pale as they approach the lateral margin. There is generally a dark brown spot in the mid-dorsal part of the fifth segment.

Wing clear. Costal-index about 4.0; 4V-index about 1.5; 4c-index about 0.6; 5x-index about 0.9 (Pl. XXXI m).

Length body 3.0 mm; wing 3.0 mm.

Eggs, larvae, pupae, chromosomes: Unknown, but Frolowa (1926) states that this species has a chromosome-complex corresponding to G-type in Pl. XXVIII.

Habitats: Sapporo (7), Kôhu (17).

Remarks: Somewhat resembles *D. immigrans* ♂ ♀. This species is probably endemic to palaearctic region. Japanese name: *Ezo-Syôzyôbae.*

(27) ***Drosophila repleta*** Wollaston 1858

D. repleta: Wollaston (1858) Ann. Mag. Nat. Hist., **41:** 117. Knab (1912) Psyche, **19:** 106–109. Sturtevant (1921) Carnegie Inst. Wash., **301:** 99–101, Fig. 36. Duda (1924) Arch. f. Naturgesch., **90:** 221. (1924) Entomologiske Meddelelser, **14:** 299–300. (1925) Arch. f. Naturgesch., **91:** 168–169.

D. punctulata: Loew (1862) Berlin Ent. Zeit., **6:** 232.

D. adspersa: Miki (1886) Wien Ent. Zeit., 5: 328.
D. nigropunctata: van der Wulp (1892)? Tijd. Ent., 34.
D. marmoria: Hutton (1901)? Trans. N. Zeal. Inst., 33: 91.

Imagos: ♂ ♀ Arista with about five branches above and three below. Antennae brown. Front over one-third width of head, wider above; gray. Second orbital bristle about one-half size of other two. Only one prominent oral bristle. A few prominent bristles on each palpus. Carina distinctly sulcate; face brown. Cheeks yellowish brown; their greatest width about one-fourth height of eye. Eyes with thick pile.

Acrostichal haris in eight rows. A pair of slightly enlarged hairs in the position of prescutellars. Mesonotum and scutellum gray; each bristle and hair arising from a dark-brown dot; these dots are irregularly fused into larger splotches. Pleurae brown. Legs pale brown; first femora darker, first coxae dark-brown below.

Abdomen gray; each segment with a wide interrupted dark brown band on its posterior margin; these bands reach the anterior margin in near the lateral edges of the segments. There is also a gray spot between the above point and the lateral margin on the four basal segments. Hypopygium is shown in Fig. 29.

Wing clear; first longitudinal vein black at the tip. Costal-index about 2.5; IV-index about 1.8; 4c-index about 1.1; 5x-index about 1.0 (Pl. XXXI i).

Length body 2.5 mm; wing 2.5 mm.

Eggs: Four filaments. *Third larvae:* Hooklets colorless. *Pupae:* Posterior spiracles divergent. *Chromosomes:* I-type (Pl. XXVIII). Testes are shown in Fig. 1 B.

Habitats: Tôkyô (18), Ôsaka (33), Amami-Ôsima (62), Naha (63), Isigakizima (64), Taihoku (71).

Remarks: This species is very common all over the world. Sturtevant (1927) reports that *Drosophila hydei* which is very closely related to *D. repleta*, was obtained from Formosa. But, so far as our specimens collected from Formosa and other districts have been examined, only *D. repleta*, was found. One generation takes about 18 days at 26°C. Japanese name: *Madara-Syôzyôbae*.

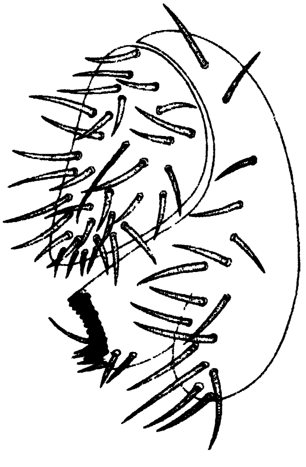

Fig. 29. Hypopygium of *D. repleta* ♂. ×ca. 150.

VI. Catalogues of Japanese species of *Drosophila*

In this chapter are shown catalogues of species of Drosophilidae from Japan described by various investigators. (from Saghalien, Hokkaido, Hondo, Sikoku, Kyûsyû, Ryûkyû Is., Formosa, Korea, Kwan-tung, Caroline Is.). In addition to these, a list is given of Drosophilidae collected by T. Komai, F. T. Peng and by G. Tomita from China, and also a list of *Drosophila* collected by M. Chino and by M. Kariya from Manchukuo (Manchuria).

There are, however, several doubtful species in these catalogues. Especially, the species described by Duda (1922–1929) need to be reexamined, for his descriptions are chiefly based on the specimens which were sent by H. Sauter from Formosa. As pointed out by many investigators of Japan, Sauter's specimens are not always correct as to their habitats.

Abbreviation of the authors' names

Coqu.	Coquillett
Dolesch.	Doleschall
Fall.	Fallén
Matsu.	Matsumura
de Meij.	de Meijere
Walk.	Walker
Woll.	Wollaston
Zett.	Zetterstedt

(1) Coquillett (1898)

Drosophila obscura Fall. (Hondo). (Probably *D. virilis* Sturtevant).

(2) Duda (1922), (1923), (1924 a), (1926), (1929)

Cacoxenus punctatus Duda (Formosa), *Drosophila ampelophila* Loew = *D. melanogaster* (Do.), *D. ananassae* de Meij. (Dolesch.) (Do.), *D. busckii* Coqu. (Do.), *D. clunicrus* Duda (Do.), *D. compressiceps* Duda (Do.), *D. curvicapillata* Duda (Do.), *D. decipiens* Duda (Do.), *D. dorsata* Duda (Do.), *D. hoozani* Duda (Do.), *D. lividinervis* Duda (Do.), *D. longifrons* Duda (Do.), *D. montium* de Meij. (Do.), *D. obscurata* de Meij. (Do.), *D. paravibrissina* Duda (Do.), *D. repleta*, Woll. (Do.), *D. silvata* de Meij. (Do.), *D. singularis* Duda (Do.), *D. unipectinata* Duda (Do.), *D. xanthogaster* Duda (Do.), *Hirtodrosophila carinata* Duda (Do.), *H. longecrinita* Duda (Do.), *H. long.* var. *curinervis* Duda (Do.), *H. long.* var. *dentata* Duda (Do.), *H. trapezina* Duda (Do.), *Incisurifrons* (*Drosophila*) *congesta* Zett. (Do.), *Leucophenga argentata* de Meij. (Do.), *L. bifasciata* Duda (Do.), *L. confluens* Duda (Do.), *L. fuscipennis* Duda (Do.), *L. guttiventris* de Meij. (Do.), *L. halteropunctata* Duda (Do.), *L. interrupta* Duda (Do.), *D. latifrons* Duda (Do.), *L. limbipennis* de Meij. (Do.), *D. lineata* de Meij. (Do.), *L. maculata* Dufour (Do.), *L. magnipalpis* Duda (Do), *L. Meijerea* Duda (Do.), *L. nigrinevis* Duda (Do.), *L. nigripalpis* Duda (Do.), *L. nigroscutellata* Duda (Do.), *L. setipalpis* Duda (Do.), *L. sordida* Duda (Do.), *L. subacutipennis* Duda (Do.), *L. subpollinosa* de Meij. (Do.), *L. umbratula* Duda (Do.), *L. varinervis* Duda (Do.), *Liodrosophila nitida* Duda (Do.), *Oxyphortica convergens* de Meij. (Do.), *Paradrosophila marginata* Duda (Do.), *P. novoguinensis* Duda (Do.), *P. oralis* Duda (Do.), *P. simplex* de Meij. (Do.), *P. scutellimargo* Duda (Do.), *P. subacuticornis* Duda (Do.), *Paramycodrosophila pictula* de Meij. (Do.), *Parascaptomyza graminum* var. *flava* Becker (Do.), *Phortica* (*Amiota*) *foliiseta* Duda (Do.), *P.* (*A.*) *variegata* Fall. (Do.), *Protho-*

stegana formorata Duda (Do.), *Scaptodrosophila divergens* Duda (Do.), *Spinulophila* (*Drosophila*) *albomicans* Duda (Do.), *S.* (*D.*) *annulipes* Duda (Do.), *S.* (*D.*) *signata* Duda (Do.), *S.* (*D.*) *tripunctata* Becker (Do.), *Spuriostyloptera multipunctata* Duda (Do.), *Stegana ingrolimbata* Duda (Do.), *Styloptera formosae* Duda (Do.), *Trichiaspiphenga invicta* Walk. (Do.).

(3) Enderlein (1922)

Zaprionus albicornis Enderlein (Formosa).

(4) Esaki (1932)

Drosophila melanogaster Meigen (Hokkaido?, Hondo, Sikoku, Kyûsyû), *D. virilis* Sturtevant (Hondo, Sikoku, Kyûsyû).

(5) Kamizawa (1934 a), (1934 b)

Drosophila suzukii (Matsu.) (Hondo).

(6) Kikkawa and Peng (The present paper).

Amiota variegata Fall. (Hondo), *Apsinota obscuripes* de Meij. (Palao), *Chymomyza obscura* de Meij. (Hondo), 27 species of *Drosophila* (see the text).

(7) Kurisaki (1925)

Drosophila melanogaster Meigen (Hondo, Sikoku, Kyûsyû).

(8) Matsumura (1931)

Drosophila funebris Fall. (Hokkaido), *Leucophenga suzukii* Matsu. = *D. suzukii* (Matsu.) (Hondo), *D. histrio* f. *jezonica* Matsu. (Perhaps *D. nigromaculata sp. nov.* (Hokkaido).

(9) Sturtevant (1921), (1927)

Drosophila hydei Sturtevant (Formosa), *D. immigrans* Sturtevant (Do.), *D. immigrans* var. *formosana* Sturtevant (Do.), *D. melanogaster* Meigen (Hondo, Kyûsyû, Formosa), *D. nasuta* Lamb (Formosa), *D. takahashii* Sturtevant (Do.).

(10) Takahashi, R. (1931) *Drosophila* species preserved in the Dept. Agric. Research Inst., Government of Formosa. (Identified by Prof. T. Shiraki).

Amiota orientalis Hendel (Formosa), *Drosomyiella abbreviata* de Meij. (Do.), *Drosophila ampelophila* Loew = *D. melanogaster* Meigen (Do.), *D. ananassae* de Meij. (Dolesch.) (Do.), *D. dorsata* Duda (Do.), *D. montium* de Meij. (Do.), *D. obscurata* de Meij. (Do.), *D. repleta* Woll. (Do.), *D. silvata* de Meij. (Do.), *D. tristipennis* Duda (Do.), *D. unipectinata* Duda (Do.), *D. xanthogaster* Duda (Do.), *Incisurifrons* (*Drosophila*) *congesta* Zett. (Do.), *Leucophenga argentata* de Meij. (Do.), *L. guttiventris* de Meil. (Do.), *L. halteropunctata* Duda (Do.), *L. interrupta* Duda (Do.), *L. lineata* de Meij. (Do.), *L. nigroscutellata* Duda (Do.), *L. paraguttiventris* de Meij. (Do.), *L. subacutipennis* Duda (Do.), *Orthostegana curvinervis* Hendel (Do.), *O. nigripennis* Hendel (Do), *Oxyphortica convergens* de Meij. (Do.), *Paradrosophila scutellimargo* Duda (Do.), *Paraleucophenga triseta* Hendel (Do.), *Parascaptomyza graminum* de Meij. (Do.), *Phortica* (*Amiota*) *varigata* Fall. (Do.), *Spinulophila* (*Drosophila*) *annulipes* Duda (Do.), *S.* (*D.*) *tripunctata* Becker (Do.), *Thaumastophila hyalipennis* Hendel (Do.), *Trichiaspiphenga invicta* Walk. (Do.).

Drosophila species of China

(1) Peng (1937) (July, 1936).

Amiota variegata Fall. (Lushan), *Drosophila ananassae* Doleschall (Shanghai), *D. auraria* Peng (Lushan, Nanchang, Sanhu), *D. busckii* Coquillett (Lushan), *D. immigrans* Sturtevant (Lushan, Sanhu), *D. melanogaster* Meigen (Lushan, Nanchang), *D. suzukii* (Matsu.) (Sanhu), *D. takahashii* Sturtevant (Sanhu), *D. sp.* (Lushan).

(2) Komai (Oct., 1936).

Drosophila melanogaster Meigen (Peking=Peiping), *D. montium* A de Meij. (Ningpo), *D. takahashii* Sturtevant (Hangchow), *D. virilis* Sturtevant (Peking=Peiping, Hangchow).

(3) Tomita (Oct., 1936).

Drosophila ananassae Doleschall (Shanghai).

Drosophila species of Manchukuo (Manchuria)

(1) Chino (1937).

Drosophila repleta Woll. (Hôten, Sinkyô) He obtained this species from Mozi (Kyûsyû) and Tairen (Kwan-tung) respectively.

D. virilis Sturtevant (Kirin=Kiturin, Sinkyô).

(2) Kariya (Aug., 1937).

Drosophila auraria Peng (Yûgakuzyô), *D. melanogaster* Meigen (Do.), *D. takahashii* Sturtevant (Do.).

VII. .Summary

The following 27 species of *Drosophila* found in Japan and adjacent localities, were described; of these 11 species seem to be new to science. The identification was based on the studies of imagos, eggs, larvae, pupae, chromosomes and of other diagnostic features.

(1) *D. coracina sp. nov.*
(2) *D. immigrans* Sturtevant 1921
(3) *D. komaii sp. nov.*
(4) *D. ananassae* Doleschall 1858
(5) *D. bipectinata* Duda 1923
(6) *D. auraria* Peng 1937
(7) *D. rufa sp. nov.*
(8) *D. montium* de Meijere 1916
(9) *D. nipponica sp. nov.*
(10) *D. ficusphila sp. nov.*
(11) *D. bizonata sp. nov.*
(12) *D. lutea sp. nov.*
(13) *D. takahashii* Sturtevant 1927

(14) *D. melanogaster* Meigen 1830
(15) *D. simulans* Sturtevant 1919
(16) *D. suzukii* (Matsumura) 1931
(17) *D. nigromaculata sp. nov.*
(18) *D. transversa* Fallén 1823
(19) *D. melanissima* Sturtevant 1921
(20) *D. sordidula sp. nov.*
(21) *D. virilis* Sturtevant 1916
(22) *D. subtilis sp. nov.*
(23) *D. busckii* Coquillett 1901
(24) *D. funebris* Fabricius 1787
(25) *D. grandis sp. nov.*
(26) *D. histrio* Meigen 1830
(27) *D. repleta* Wollaston 1858

In the last chapter, are presented catalogues of Japanese species of Drosophilidae reported by previous investigators, and also lists of *Drosophila* collected from China and Manchukuo (Manchuria).

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EXPLANATION OF PLATES

PLATE XXVII

Schematic structure of *Drosophila komaii*.

A and **B** (Head and thorax. Left, side view; right, dorsal view, ×ca. 30)
AB—Abdomen
AC—Acrostichal hairs. Several rows of acrostichal hairs between the dorsocentral rows are very convenient for taxonomic study. Unless otherwise stated, the count is to be taken just in front of the anterior dorsocentral bristles.
AN=Antenna
AR=Arista
BU=Bucca
CH Cheek
CO-1, CO-2, CO-3=Coxa-1, Coxa-2, Coxa-3
DC (A, P)=Dorsocentrals (Anterior, Posterior)
FR—Front
HA—Haltere
HP—Hypopleura
HU—Humerus
HUM (U, L)—Humerals (Upper, Lower)
ME—Mesonotum
MS=Mesopleura
MST—Mesosternal
MT=Metanotum
OB-1, OB-2=Oral-1 (First oral or first vibrissa), Oral-2 (Second oral or second vibrissa)
OC=Ocellus
OCL=Ocellar
OR-1, OR-2, OR-3=Orbital-1 (First orbital or posterior reclinate orbital), Orbital-2 (Second orbital or anterior reclinate orbital), Orbital-3 (Third orbital or proclinate orbital)
P=Palpus
PA (A, P)=Post-alars (Anterior, Posterior)
PP=Position of prescutellars (Absent in this species)
PSR=Presutural
PT—Pteropleura
PV=Postvertical
SA (A, P)=Supra-alars (Anterior, Posterior)
SC (A, P)=Scutellars (Anterior, Posterior)
SCT=Scutellum
STP (A, M, P)—Sternopleurals (Anterior, Middle, Posterior)
V (A, P)=Verticals (Anterior, Posterior)

C (Frontal view of head. ×ca. 30)
AN Antenna
CA—Carina
E=Eye
FA=Face
OB-1, OB-2=Oral-1, Oral-2
OC—Ocellus
OCL—Ocellar
OR (1, 2, 3)—Orbitals (1, 2, 3)
P=Palpus
PR—Proboscis
PV—Postverticals
V (A, P)=Verticals (Anterior, Posterior)

D and **E** (Abdomens. ×ca. 30)
1T-8T—First tergite—Eighth tergite
2S-7S—Second sternite—Seventh sternite
AP—Anal plate
C—Clasper
HA—Haltere
GA—Genital arch
SP—Spiracle

F (Male-Hypopygium. ×ca. 150)
AP—Anal plate
C—Clasper
GA=Genital arch

G (Prothoracic leg. ×ca. 60)
APL—Apical bristle
CL—Claw
CO=Coxa
FE=Femur
PAPL—Preapical bristle
TA 1, 2, 3, 4, 5—Tarsal joints (First, second, third, fourth, fifth)
TI—Tibia
TR=Trochanter

H (Wing. ×ca. 30)
I-BC—First basal cell
II-BC=Second basal cell
I-PC=First posterior cell
II-PC=Second posterior cell
III-PC=Third posterior cell
AC=Anal cell
ACV=Anterior crossvein

AL=Alula
ANCV=Anal crossvein
AUX=Auxiliary cell
CC=Costal cell
CSV(MV)=Costal or marginal vein
DC=Discal cell
HCV=Humeral crossvein
LI-LVI=Longitudinal veins (First—Sixth)
PCV=Posterior crossvein
SMC=Submarginal cell

Technical terms:

Acrostichal hairs: See A and B

Sterno-index: The length of anterior sternopleural divided by the length of posterior sternopleural bristle.

Costal-index: The length of second section of the costal vein divided by the length of its third section.

4V-index: The length of fourth (distal) section of the fourth vein (LIV) divided by the length of its third section.

4c-index: The length of third section of the costal vein divided by the length of third section of the fourth vein (LIV).

5x-index: The length of third (distal) section of the fifth vein (LV) divided by the length of the posterior crossvein.

Plate XXVIII

Chromosome types of *Drosophila* species

Plate XXIX

Map of geographic distribution

Plate XXX

"Sump" photographs of *Drosophila*

a. Photograph showing hooklets on the ventral surface of the larva (*D. melanogaster*). ×ca. 130.
b. Magnified photograph of the above. ×ca. 600.
c. Compound eye of *D. subtilis*. ×ca. 600
d. The same of *D. immigrans*. ×ca. 600.

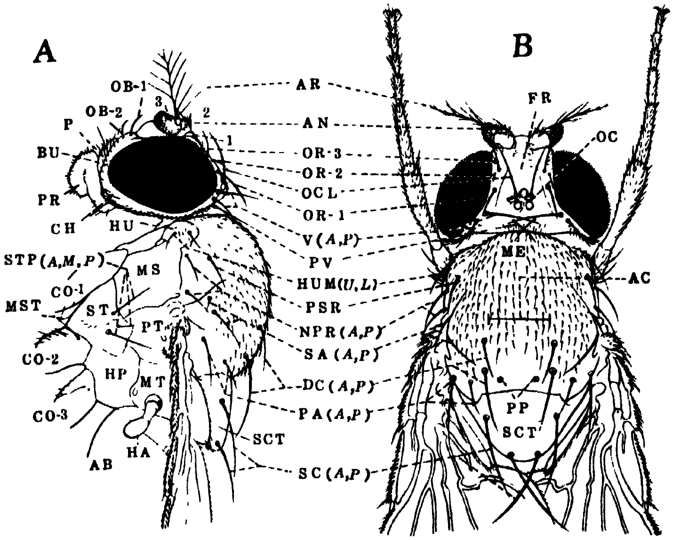
Plate XXXI

Wings of *Drosophila* species. ×ca. 12.

a. *D. coracina*
b. *D. immigrans*
c. *D. grandis*
d. *D. nigromaculata*
e. *D. ananassae*
f. *D. bizonata*
g. *D. auraria*
h. *D. sordidula*
i. *D. repleta*
j. *D. melanissima*
k. *D. virilis*
l. *D. suzukii*
m. *D. histrio*
n. *D. melanogaster*
o. *D. takahashii*
p. *D. lutea*
q. *D. ficusphila*
r. *D. subtilis*

Plate XXXII

Total figures of *D. suzukii*, *D. komaii*, *D. virilis* and *D. subtilis*. ×ca. 20.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3
2
OB-2
P
BU
1
PR
CH
HU
STP(A,M,P)
MS
CO-1
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ST
PT
CO-2
HP
MT
CO-3
HA
AB
SCT
AR
AN
OR-3
OR-2
OCL
OR-1
V(A,P)
PV
HUM(U,L)
PSR
NPR(A,P)
SA(A,P)
DC(A,P)
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AC
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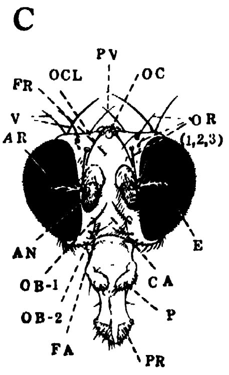
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AN
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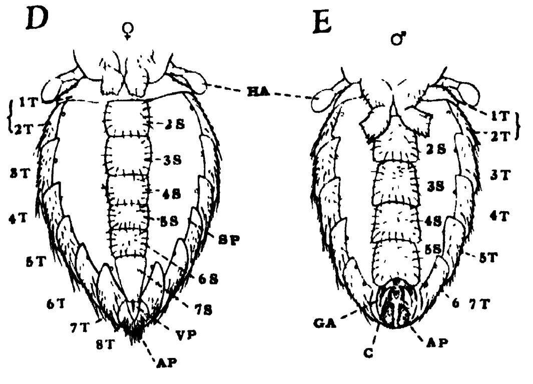
CA
OB-2
P
FA
PR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7T
VP
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GA
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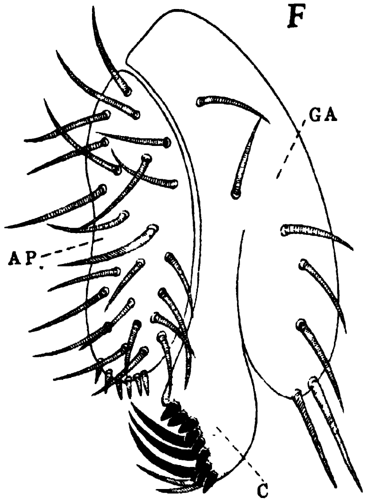
AP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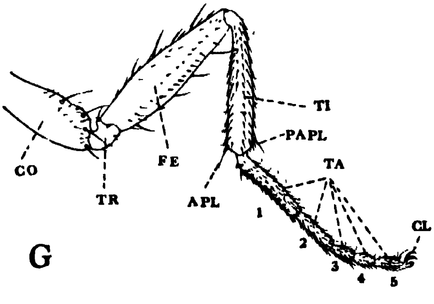
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PAPL
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CO
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FE
APL
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2
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4
5
CL
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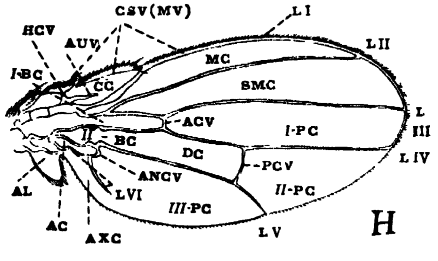
CSV(MV)
LI
HCV
AUV
LII
MC
I-BC
CC
SMC
L
III
ACV
I-PC
II
BC
DC
PCV
L IV
ANCV
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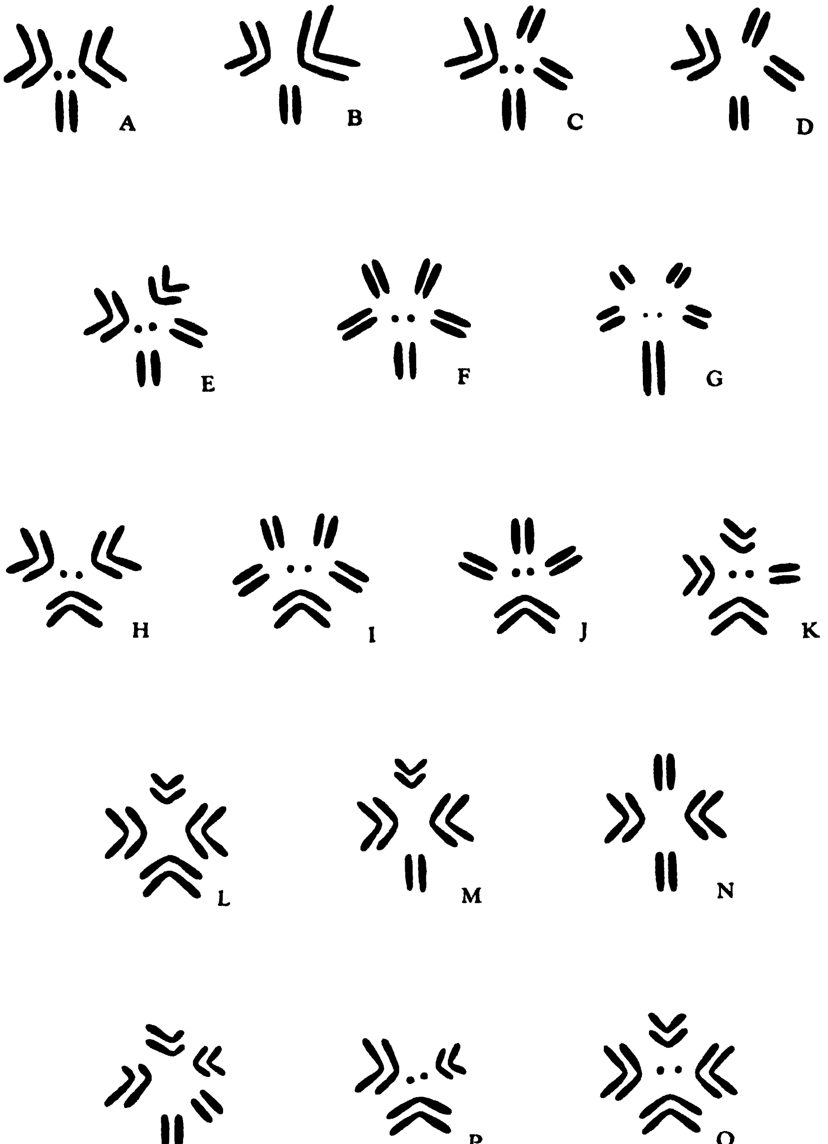
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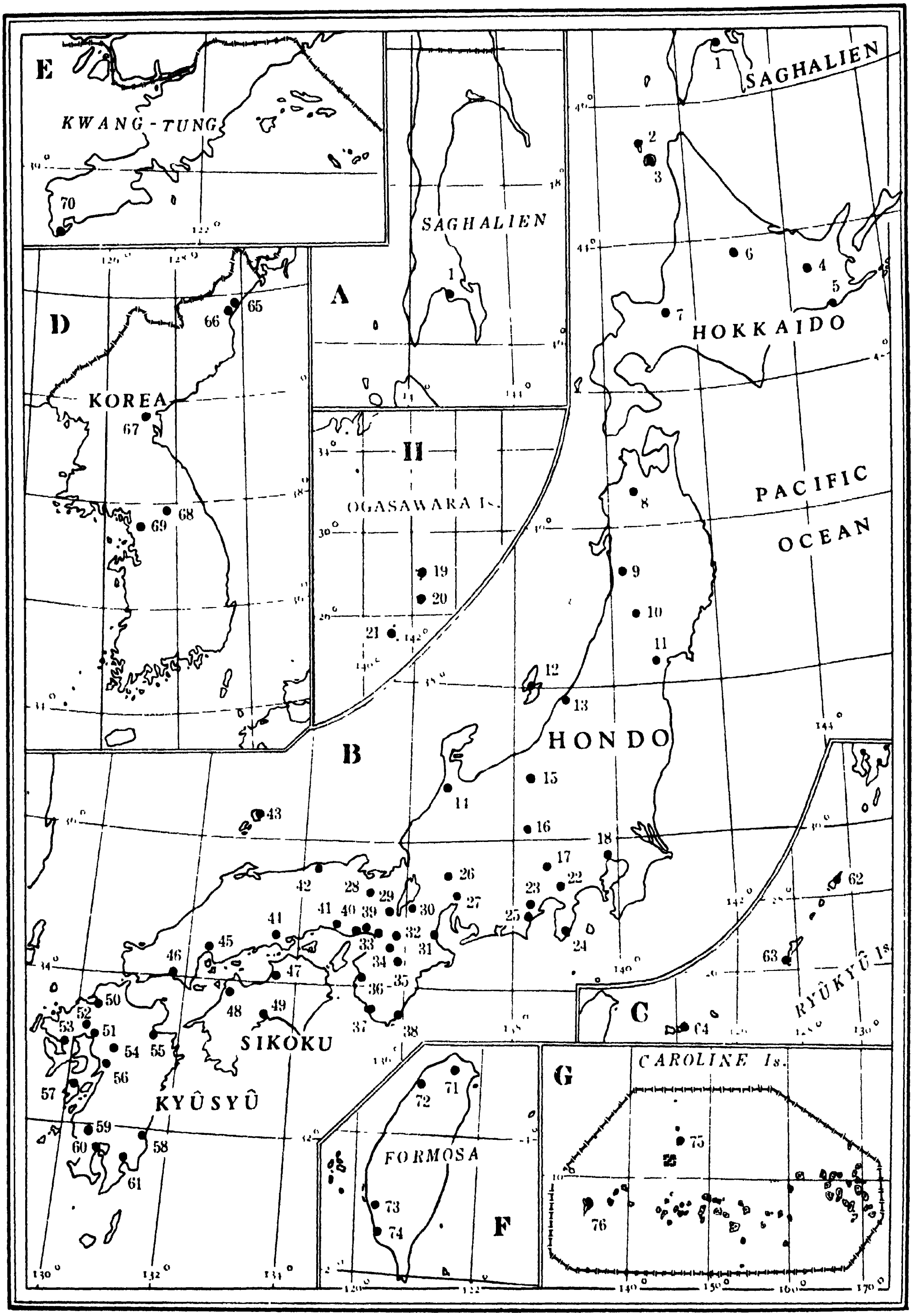
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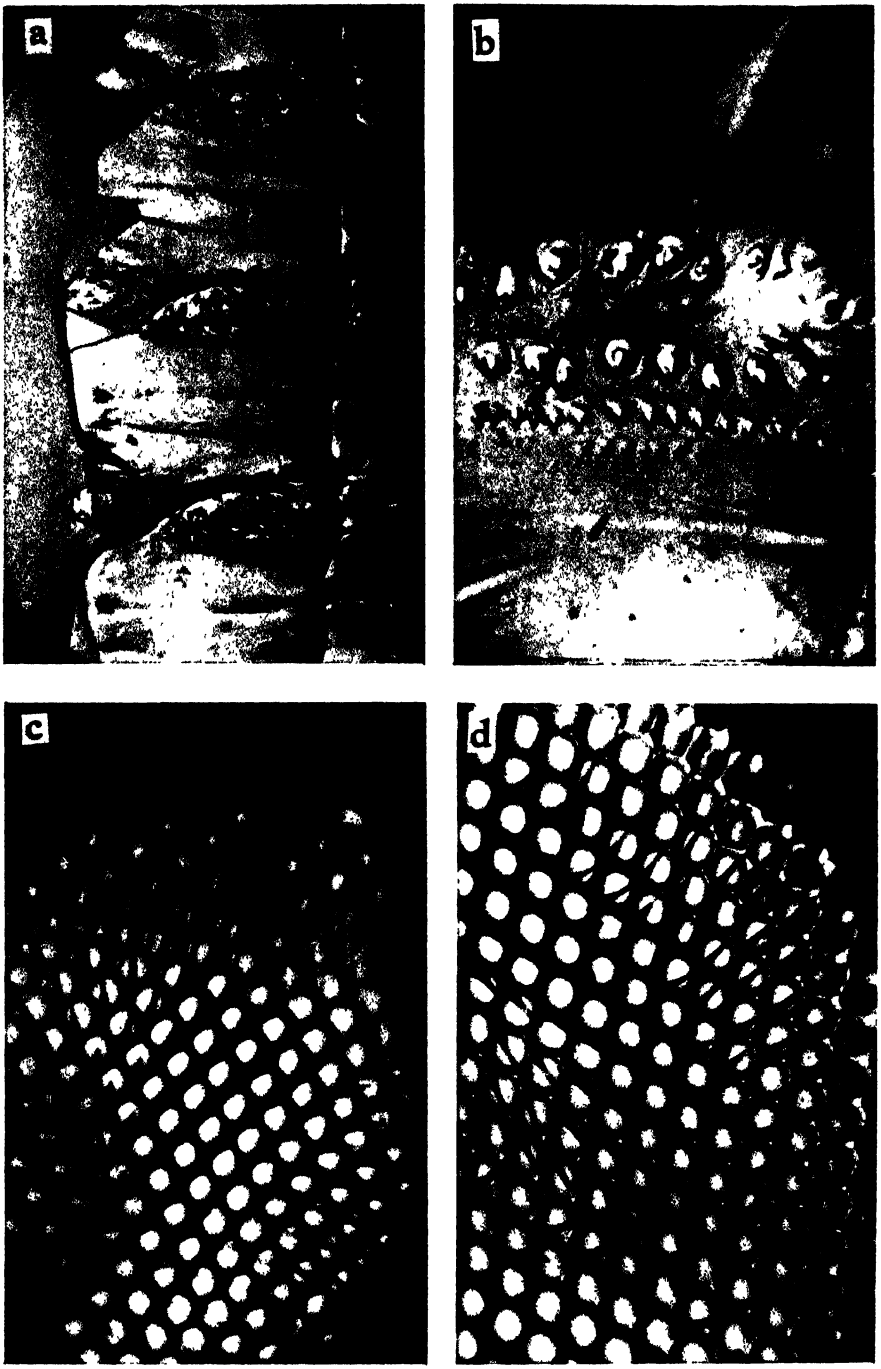
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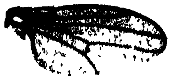

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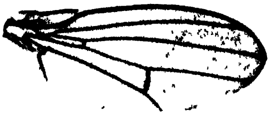

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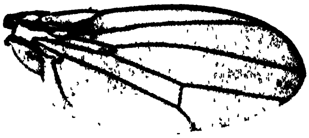

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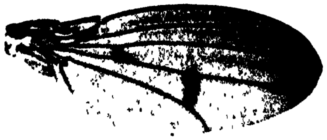

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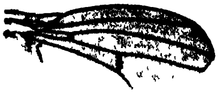

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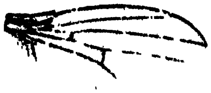

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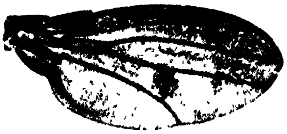

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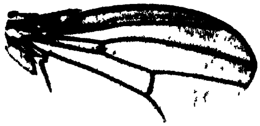

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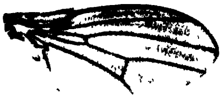

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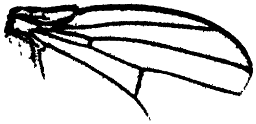

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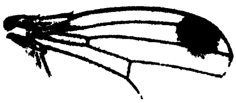

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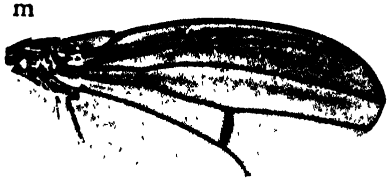

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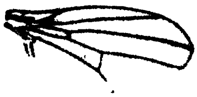

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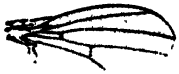

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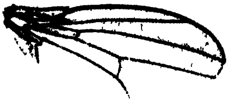

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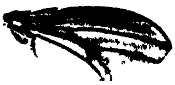

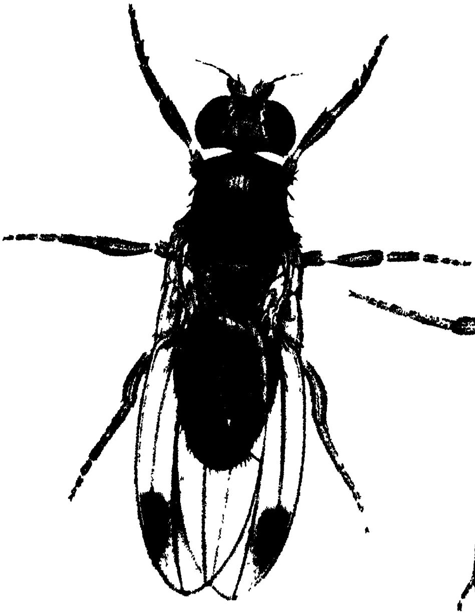

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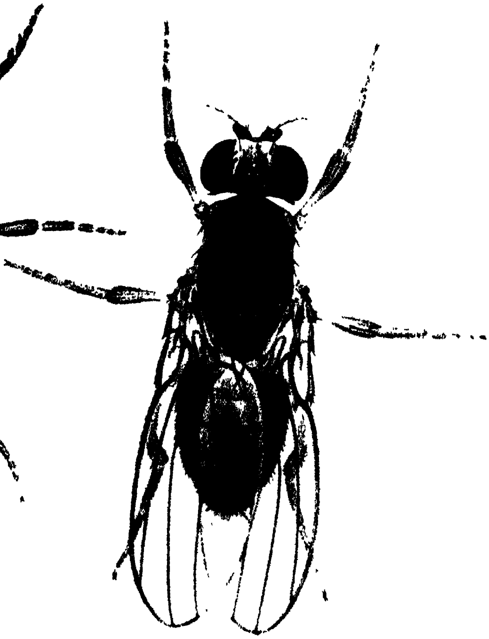

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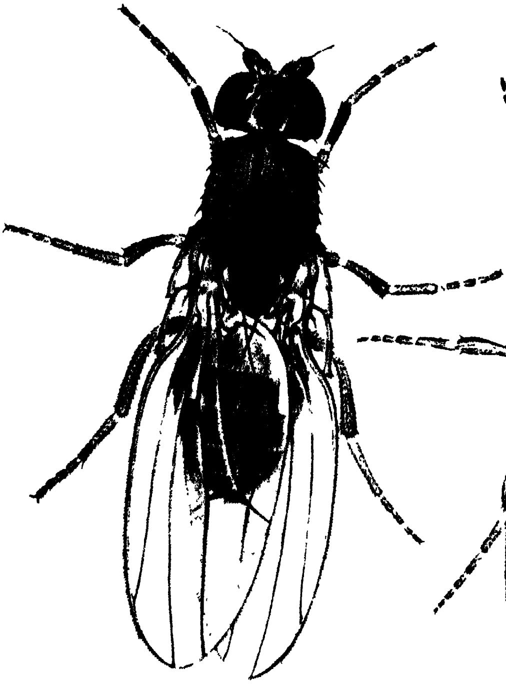

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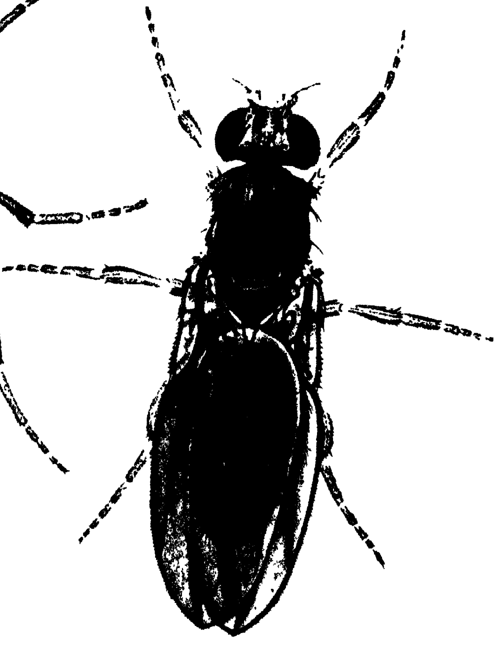

D. subtilis ♀

24. Studies on the Helminth Fauna of Japan
Part 22. Two New Species of Frog Cestodes

By Satyû YAMAGUTI

Laboratory of Parasitology, Kyôto Imperial University

(With Plates XXXIII-XXXV)

Of the frog cestodes none has yet been reported from Japan, and it is after a long search that I have found two species of them, one from *Rana nigromaculata* Hallowell and the other from *Rana japonica* Günther.

From *Hyla arborea japonica* Günther and *Rhacophorus schlegeli* var. *arborea* Okada et Kawano also have been obtained some examples, but the specific identification is not possible at present owing to absence of full-grown segments.

Ophiotaenia ranae n. sp.

Pl. XXXIII, Figs. 1-4; Pl. XXXV, Figs. 9-12.

Rana nigromaculata from Lake Kobata near Kyôto was found infected in the small intestine with large numbers of the tapeworm described below.

As fixed in alcohol, stained and mounted, the worm is over 16 cm long, comprising more than 370 segments, with a maximum breadth of 2.08 mm at the anterior mature segments, whence it tapers gradually toward the posterior extremity. The scolex, 0.31-0.33 mm dorsoventrally and 0.32-0.38 mm transversely, has four prominent suckers 0.15-0.2 mm across in a dorsal and ventral pair. It is more or less distinctly constricted immediately behind the suckers. In youngest unsegmented examples a well-defined rounded or disk-shaped glandular organ (Fig. 1 a) is seen at the apex. It is 0.12-0.14 mm in diameter and packed with fine eosinophil secretion granules produced by the gland cells, which are pressed against the membranous capsule and contain a pyknotic nucleus and basophil protoplasmic granules. A vestige of this organ may occasionally be observed even in larger examples. The neck is 2.5-5.5 mm long and widens posteriorly. The short immature segments become longer and broader posteriorly and attain the maximum breadth when the eggs begin to appear in the uterus. The gravid segments are almost uniform in breadth and have inconspicuous intersegmental notches on the lateral margins. Their length and breadth are very variable; some are broader than long and others longer than broad, especially so when the uterus is emptied or senile atrophy sets in. In strongly atrophied segments the maximum length is 1.38 mm and the breadth only 0.4 mm.

The cuticle is 4-6 μ thick. The subcuticular muscle and cell layers are well differentiated, while the dorsoventral muscles are not developed. The inner longitudinal muscle bundles are very close to each other and form a distinct sheath for the medullary parenchyma. The lateral nerve trunk lies just inside this muscle sheath, and immediately dorsal to the cirrus pouch and vagina on the pore side. The wide ventral excretory stems run just inside the ventral inner longitudinal muscle about one-fifth to one-seventh of the proglottis breadth from the lateral margins in mature and gravid segments, with a transverse anastomosis between at the posterior end of each segment. The narrow, thick-walled dorsal excretory stems lie at about the middle of the medulla in the same sagittal plane as the ventral or slightly inside or outside of it, between the outer and the inner group of the testes and along the outer margins of the ovary. On the pore side they pass through the narrow space between the dorsal inner longitudinal muscle and the terminal genital organs (cirrus pouch and vagina). At the scolex inside the four suckers there is a complete ring (Fig. 1 r) formed by the dorsal and ventral stems of the two sides, besides supplementary communications between the two stems of the same side.

The follicular testes extend in two lateral fields between the vitellaria and the uterus from the anterior end of the segment to the level of the anterior end of the ovary; they are divided by the excretory stems into a smaller outer and a larger inner group and interrupted on the pore side by the terminal genitalia. Their number varies greatly according to proglottides; the outer group consists of 10–45 testes and the inner of 25–70, the total number not exceeding 115 on one side. Generally speaking they are more numerous in immature proglottides than in mature and gravid ones. The vas deferens is strongly convoluted at the posterior half of the anterior third of the segment between the cirrus pouch and the median line. The elongate oval or club-shaped cirrus pouch extends a little further inwards than the excretory stems, but when the cirrus is extruded, it becomes smaller and barely reaches to that limit. It contains at the base a convoluted ductus ejaculatorius, whose distal portion is relatively wide and well eversible. The cirrus is slender and somewhat swollen at the base and may attain a length of about 0.1 mm when fully protruded. The genital sinus, opening on the lateral margin at about the middle of its anterior third indifferently on the right or left, appears as a somewhat inconspicuous notch but may often be obliterated.

The two-winged ovary extends transversely at the posterior end of the segment between the excretory stems. As the development proceeds, the two lobulated outer ends of the ovary become enlarged anteroposteriorly, so that the entire organ assumes an H- or an inverted M-shape. After joining the vagina the germiduct is thrown into convolutions in the median line behind the ovary and then unites with the vitelline duct. The sinuous uterine duct proceeeds forwards in the median line on the dorsal side of the ovary and uterus and opens into the latter at about the middle of the segment. The median uterus extending between the anterior end of the segment and the ovary sends out a number of lateral pouches filled with eggs. When fully distended it occupies the middle half of the segment and empties the eggs through the ventral median slit formed by its rupture. After the eggs have been discharged the uterine pouches show irregular secondary diverticula. The vagina running forward on the dorsal side of the uterine stem passes immediately in front of the vas deferens and anterodorsal to the cirrus pouch, and opens into the genital sinus anterior and dorsal to the male pore. The finely acinous vitellaria extend in the lateral marginal medulla throughout the proglottis length, partly overlapping the outer group of the testes and intruding into the cortex through the space between the inner longitudinal muscle bundles. The vitelline ducts from the two sides run transversely ventral to the ovary and unite with each other slightly to the right of the median line to form a short common duct joining the germiduct.

In the fresh state the transparent outer egg shell is 28–45 μ and the inner 21 μ in diameter. The oncosphere is usually oval and 13–15 μ long, and its hooks are 6 μ long. As fed to *Mesocyclops dybowskyi* (Lande)* the oncosphere liberated itself in the midgut of the copepod and penetrated into the body cavity (Fig. 11), where it grew in a week into a procercoid (Fig. 12) provided with four suckers measuring each 40 μ in diameter, an apical organ consisting of a rosette-shaped mass of elongate glandular cells, and a small caudal vesicle containing three pairs of embryonic hooks. Further development of the worm is reserved for a future study.

This species is characterized by the vitellaria intruding into the cortex through the longitudinal muscle sheath. In this respect it differs from any of the Proteocephalids recorded from the frog, such as *Proteocephalus tigrinus* Woodland, 1925, *Ophiotaenia schultzei* (Hungerbühler, 1910), *O. magna* Hannum, 1925, *O. saphena* Osler, 1931 and *O. olor* (Ingles, 1936). That the testes extend laterally to the excretory stems in the present species is also worth noting.

Crepidobothrium olor Ingles, 1936, should be transferred to *Ophiotaenia* La Rue on account of absence of marginal notches on the suckers. I agree with La Rue in considering *Crepidobothrium* as distinct from *Ophiotaenia*, because the large, swollen scolex combined with large suckers with notched margins is a very prominent distinguishing feature of more than specific significance.

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*Identified by Dr. M. Uéno, to whom I with to express my best thanks here.

Baerietta japonica n. sp.

Pl. XXXIV, Figs. 5–8; Pl. XXXV, Figs. 13–14.

Unless otherwise stated the following description is based on three series of transverse sections and a number of mature specimens fixed in acetic sublimate under cover glass pressure and stained with Heidenhain's hematoxylin.

The filiform, cylindrical strobilus is up to 27 mm long, with a maximum breadth of 0.7 mm* at about the middle, whence it tapers gradually toward the extremities. The scolex is rounded in front and bears four suckers 54–84 μ in diameter and passes imperceptibly into the long slender neck. The immature as well as mature segments are definitely broader than long and have smooth lateral margins, without indication of external segmentation, and are distinguishable from one another only by the genital sets. As the parauterine organs begin to be hollowed out for the eggs the segments become elongated and swollen at the middle to take a barrel-shape and measure 0.15–0.25 mm long by 0.12–0.21 mm broad.

The cuticle, up to 3 μ thick, is beset with exceedingly minute spines all over except at the head end. The underlying muscles are weakly developed. The subcuticular cells are large and form a very conspicuous layer. The inner longitudinal muscle sheath is moderately well developed except in the post-mature segments, where it is markedly atrophied. The dorsal and ventral excretory stems lying at about the middle of each lateral half of the body are united at the scolex (Fig. 5) and rather coarsely undulating in the anterior region irrespective of the internal segmentation, without any transverse anastomosis in each segment, but sooner or later the ventral stems enter into cross-anastomosis at the posterior end of each segment. The dorsal stems are relatively wide anteriorly, but are barely recognizable posteriorly. The nerve cord lies on each side just inside the longitudinal muscle sheath. Some distance, at most 7 mm, behind the head, the male genital anlagen appear in the dorsal medulla. The genital pore is not found yet at this stage of development, but as soon as the female genital anlagen appear in the ventral medulla the genital pores open to the outside on the lateral margins, indifferently on the right or left, the two succeeding occasionally fused together. In the post-mature segments, however, they tend to disappear together with the terminal genital ducts of both sexes.

The two testes are rather rounded in mature segments, measuring 17–24 μ by 21–72 μ, and lies in the dorsal part of the medulla, one dorsal to the uterus and the other dorsal to the ventral excretory stem. The vas deferens, formed by union of the two short vasa efferentia arising from the inner ends of the testes, may be distended with spermatozoa in form of a tubular vesicula seminalis and is more or less strongly convoluted, though stretched in the posterior segments. The club-shaped cirrus pouch, 30–48 × 18–26 μ and containing a more or less spirally twisted ductus ejaculatorius and numerous small cells with rounded nuclei, has relatively thin muscular wall and lies in the lateral field with its swollen base intruding into the medulla anteriorly but immediately outside the longitudinal muscle sheath posteriorly. With the development of the para-uterine organs it tends to degenerate and disappears almost completely in the posterior region where the eggs are found in the para-uterine organs. There is a small genital atrium lined by cuticle, into which opens the ductus ejaculatorius and immediately behind it the vagina.

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* Exaggerated by pressure applied on cover glass.

The ovary appears in the ventral part of the medulla some distance behind the testicular anlage. When fully developed it is oval, 27 33 μ by 38–48 μ and is filled with a number of large germ cells all at the same stage of development. The germiduct arising from the dorsal side of the ovary runs dorsad and after joining the vagina unites with the short duct from the vitellarium to form the uterus. The germ cells are pushed one after another into the uterus, while the ovary disappears and the germiduct distended with ova forms part of the uterus. At the anterior wall of the uterus soon appears a reticular para-uterine organ and as it develops it is divided in front into two parts, a dorsal and a ventral, and is surrounded at each anterior end by very compact parenchyma appearing like a dark spot. From the apex of each para-uterine organ is budded out anteriorly a small diverticle (Fig. 13), which becomes enlarged posteriorly into a rounded chamber as the reticular tissue of the para-uterine organ degenerates. Thus are formed two hollow para-uterine organs communicating with each other at the base and containing a small number of eggs, which are now fully mature. There are from five to nine eggs in each full-grown segment. The uterus proper tends to degenerate as the para-uterine organ develops and finally disappears when the latter serves as egg reservoir. The immature eggs are free in the uterus and not enclosed in capsules. This fact accounts for easy transfer of eggs from the uterus to the para-uterine organ. Inside the pliant outer shell, which is readily mistaken for a uterine or egg capsule, there is a clear space occupied by some liquid, yolk granules and vesicular nuclei of degenerating yolk cells. In mature eggs the outer shell assumes a more definite oval form and measures 36 12 μ by 25 30 μ and contains homogeneous substance. The thick embryonic shell is 23–30 μ by 18·24 μ and the hooks are 12–15 μ long in life. The vitellarium is oval, measuring 20–27 μ by 27–30 μ and lies dorsal to the ovary, but as the uterus develops it becomes atrophied and lies immediately posterior or posteroventral to the uterus, and finally disappears completely. The very narrow vagina opening into the genital atrium immediately behind the male genital pore runs inwards behind the cirrus pouch and vas deferens, but in gravid segments its connection with the part of the uterus corresponding to the original germiduct is unable to trace. With the disappearance of the male terminal ducts the vagina is also no more recognizable.

Habitat. Small intestine of *Rana japonica* Günther.

Locality and date. Near Okayama; August 21, 1937.

Type and paratypes in Yamaguti Helminthological Collection.

A similar worm was found in the small intestine of *Hyla arborea japonica* Günther from Suwa, Nagano Prefecture, and of *Rhacophorus schlegelii* var.

arborea Okada et Kawano from near Kyoto, but since the specimens are not yet fully mature, the specific identification is not possible.

This species resembles ***Baerietta baeri*** Hsü, 1935, in the number of testes and para-uterine organs, but differs from it in egg size. It seems very likely that the uterine capsule observed by Hsü is nothing but the outer egg shell.

LITERATURE

Hsü, H. F. Contribution a l'étude des cestodes de Chine. Rev. Suiss. Zool., **42** (22), 1935, 521–530.

EXPLANATION OF PLATES

Pl. XXXIII. *Ophiotaenia ranae* n. sp.

Fig. 1. Scolex; ventral view.
Fig. 2. Gravid segment; ventral view.
Fig. 3. Segment with empty uterus; ventral view.
Fig. 4. Section of scolex of youngest example showing apical organ; ×200.

Pl. XXXIV. *Baerietta japonica* n. sp.

Fig. 5. Scolex; ventral view.
Fig. 6. Mature segments; lateral view.
Fig. 7. Mature segments with reticular para-uterine organs; ventral view.
Fig. 8. Gravid segment with hollow para-uterine organs; ventral view.

Pl. XXXV.

Fig. 9–10. Transverse sections of *Ophiotaenia ranae.*
Fig. 11. *Mesocyclops dybowskyi* used for infection experiment, ×25.
Fig. 12. Same infected with procercoid of *Ophiotaenia ranae*, ×100; 7 days after infection.
Fig. 13. *Baerietta japonica* showing uterus proper filled with eggs and reticular para-uterine organs with anterior diverticles; ventral view.
Fig. 14. Transverse section of *Baerietta japônica* showing two hollow para-uterine organs containing full-grown eggs, ×200.

ABBREVIATIONS USED IN FIGURES

a apical organ, *at* genital atrium, *cp* cirrus pouch, *d* vas deferens, *dv* dorsal excretory vessel, *e* egg, *fc* fertilization canal, *gp* genital pore, *il* inner longitudinal muscle, *n* nerve trunk, *o* ovary, *p* procercoid, *pu* para-uterine organ, *r* excretory ring, *s* sucker, *sg* shell gland, *t* testis, *ta* transverse anastomosis, *u* uterus, *vg* vagina, *vd* vitelline duct, *vt* vitellaria, *vv* ventral excretory vessel.

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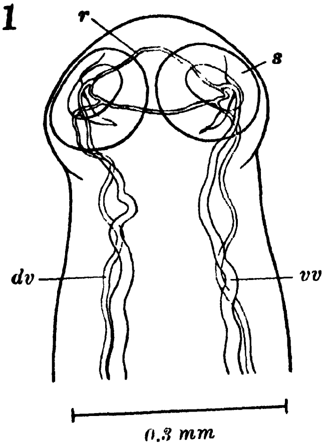
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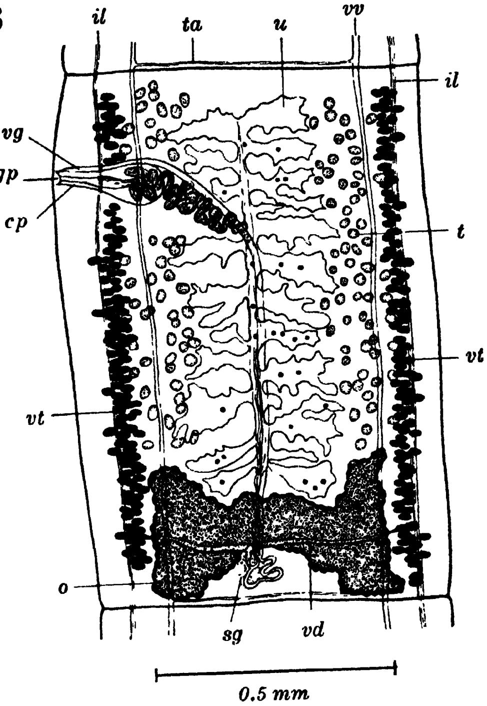
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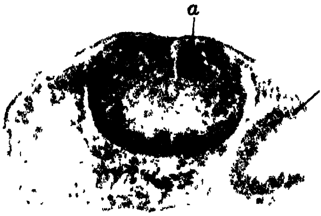
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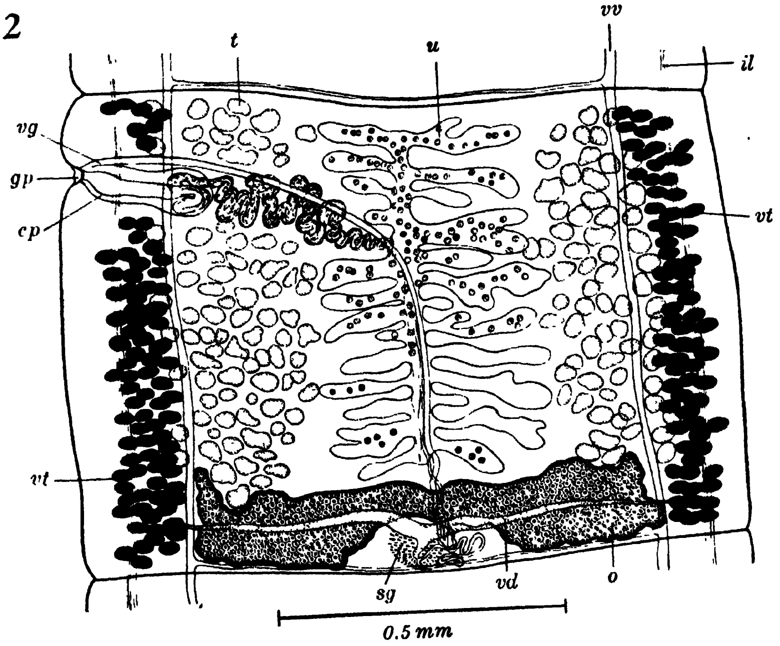
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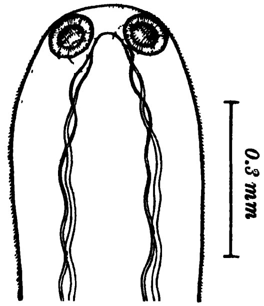
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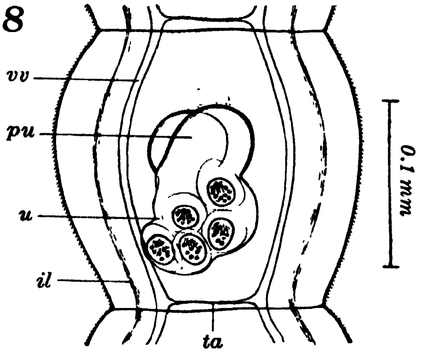
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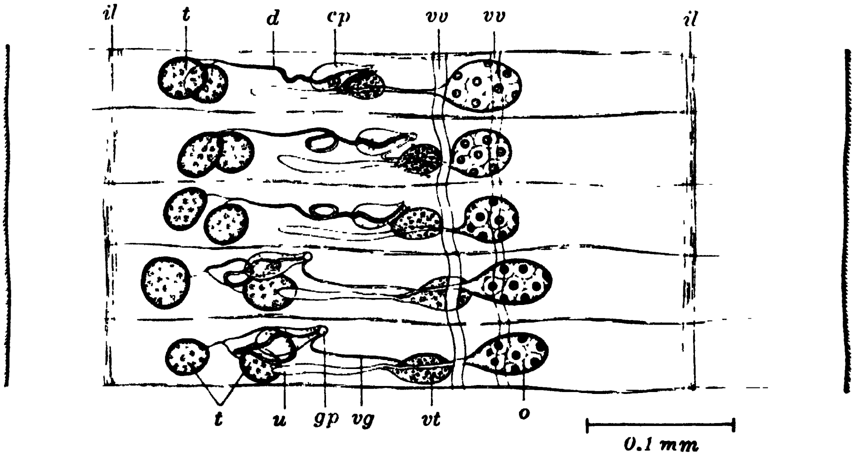
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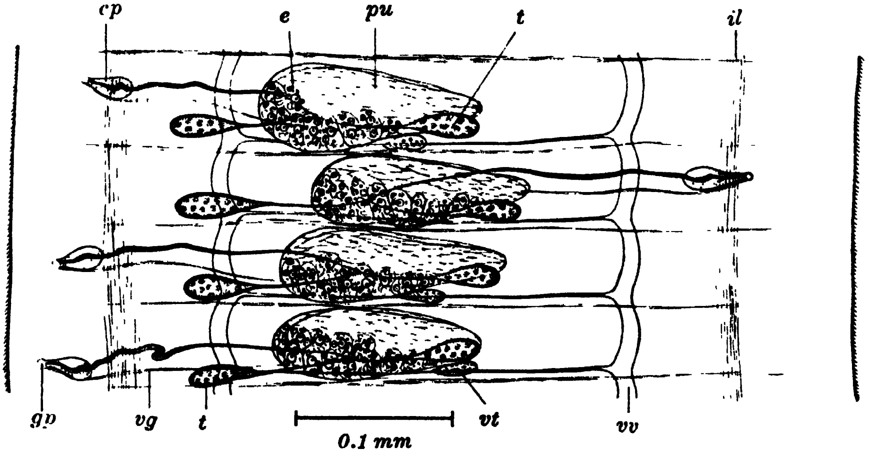
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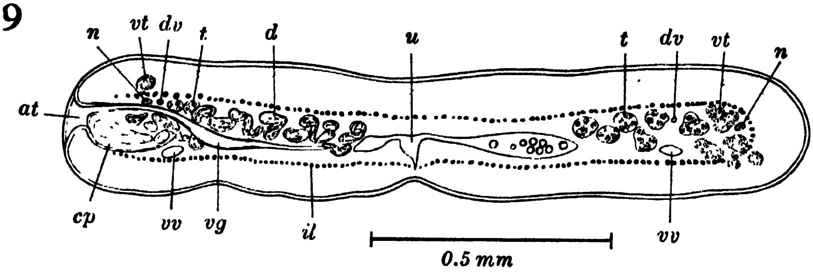

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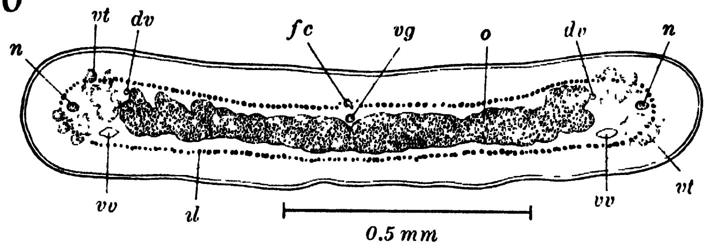

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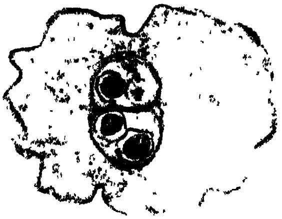

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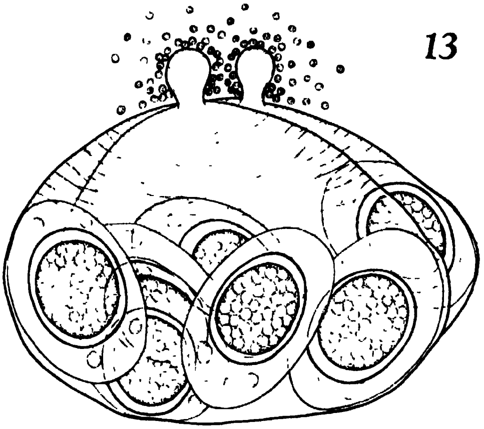

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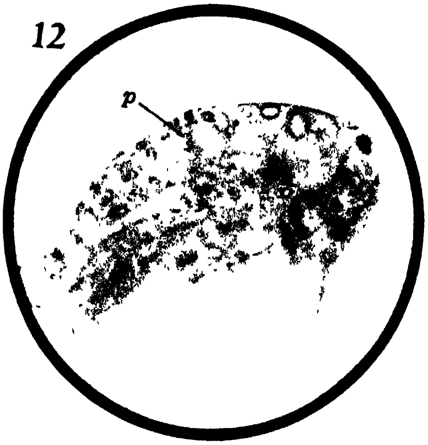

11

25. Polyclads from Amakusa, Southern Japan[1]

By Kojiro KATO

Mitsui Institute of Marine Biology, Susaki near Simoda, Idu

(With 26 Text-figures and Plates XXXVI–XXXVII)

The present paper deals with the polyclads which were mainly obtained by the author in June, 1937, in the neighborhood of the Amakusa Marine Biological Laboratory at Tomioka, Kumamoto Prefecture. Here, I wish to express my cordial thanks to Professor H. Ohshima for the use of the laboratory as well as my sincere gratitude to Mr. Kikutarô Baba for the privilege extended to me during my stay in Tomioka.

The collection includes the following twenty-two species, of which ten appear to be new to science.

Order Polycladida
  Suborder Acotylea
    A. Section Craspedommata
      Family Discocelidae
        1. *Discocelis pusilla* sp. nov.
        2. *Discocelis japonica* Yeri et Kaburaki
      Family Stylochidae
        3. *Kaburakia gloriosa* sp. nov.
      Family Cryptocelidae
        4. *Cryptocelis amakusaensis* Kato
    B. Section Schematommata
      Family Leptoplanidae
        5. *Notoplana humilis* (Stimpson)
        6. *Notoplana delicata* Yeri et Kaburaki
        7. *Notoplana serica* sp. nov.
        8. *Hoploplana ornata* Yeri et Kaburaki
      Family Planoceridae
        9. *Planocera reticulata* (Stimpson)
      Family Diplosolenidae
        10. *Pseudostylochus obscurus* (Stimpson)
        11. *Pseudostylochus meridialis* sp. nov.
    C. Section Emprosthommata
      Family Cestoplanidae
        12. *Cestoplana marina* sp. nov.
  Suborder Cotylea
      Family Pseudoceridae

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[1] Papers from the Amakusa Marine Biological Laboratory, No. 66.

13. *Pseudoceros atropurpureus* Kato
14. *Pseudoceros tomiokaensis* sp. nov.
15. *Pseudoceros memoralis* sp. nov.
16. *Pseudoceros pius* sp. nov.

Family Eureleptidae

17. *Cycloporus papillosus* (M. Sars)

Family Prosthiostomidae

18. *Prosthiostomum grande* Stimpson
19. *Prosthiostomum auratum* Kato
20. *Prosthiostomum vulgaris* Kato
21. *Prosthiostomum sonorum* sp. nov.
22. *Amakusaplana ohshimai* gen. et sp. nov.

1. *Discocelis pusilla* sp. nov.

(Pl. XXXVI, Figs. 1, 2; Text-figs. 1-3)[1]

Several specimens of this small flatworm were found on *Zostera* in Tomioka Bay.

The largest specimen, 10 mm in length by 4.5 mm in width, is somewhat oval in form, having the anterior end more rounded than the posterior. The ground color of the dorsal surface is opaque white, blotched with a number of round, light brown spots which densely occur in the central parts.

There is no tentacle. At the level of the first fourth of the body lies the brain, on either side of which occur tentacular and cerebral groups of the eyes. The cerebral eyes are arranged in front of the brain, save for one or two ocelli behind it. The marginal eyes are present along the border of the anterior third of the body. The plicated pharynx occupies one-third the body-

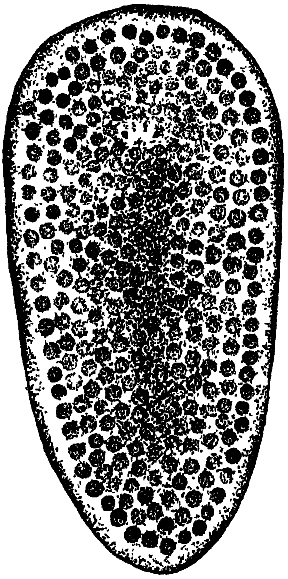

Fig. 1. *Discocelis pusilla.* ×7.

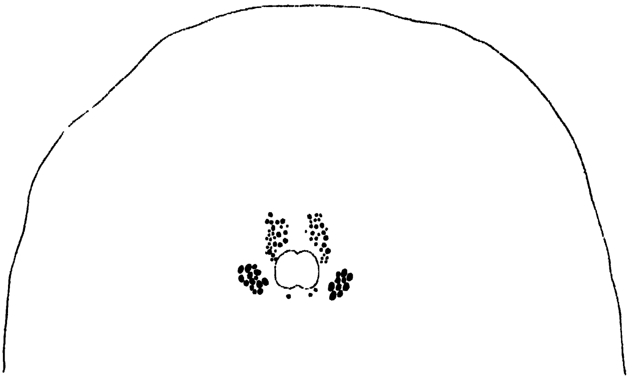

Fig. 2. *Discocelis pusilla*; arrangement of eyes. ×18.

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[1] Abbreviations in this and subsequent figures see p. 575.

length, lying in the middle of the body, and the mouth is situated near the posterior end of the pharynx as in *Discocelis japonica* (Kato, 1937 a).

A common genital pore is placed at the anterior limit of the last third of the body and leads into a widely flat common genital atrium, into which open an ejaculatory duct and a vagina. As in *japonica*, many muscular villus-like projections are vertically disposed in the atrium. The prostate glands which are still in a rudimental condition, are distributed in a small number over the external surface of the projections. The ejaculatory duct proceeds anteriad for some distance and is divided into two seminal canals. The vaginal opening occurs in the postero-ventral side of the atrium in the median line, while in both *japonica* and *tigrina* (Lang, 1884) it opens near the common genital pore. The vagina runs first ventrad and then proceeds backward for a long distance to receive a common uterine duct. In my specimens, the Lang's glandular vesicle is not fully developed and merely represented by a large mass of nuclei. The shell secretion is not yet formed.

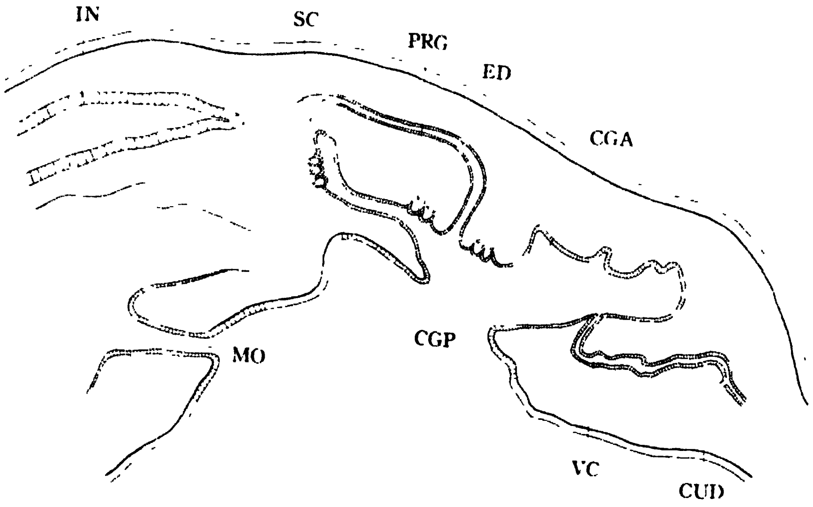


Fig. 3. *Discocelis pusilla*, sagittal section through genital organs. ×70.

The genus *Discocelis* contains four valid species: *D. tigrina*, *lichenoides* from the Mediterranean Sea, *herdmani* from Ceylon and *japonica*. *D. herdmani* is characterized by the presence of separate genital pores, and *lichenoides* by its milky white color. This species, though presenting some resemblance to *tigrina* and *japonica*, is readily distinguished from them by the small size of the body, the arrangement of the cerebral eyes as well as the position of the vaginal opening.

2. *Discocelis japonica* Yeri et Kaburaki

Discocelis japonica Yeri et Kaburaki, 1918, pp. 3–5; Kato, 1937 a, pp. 212–213.

Two specimens were collected at Siroiwa-zaki.

3. *Kaburakia gloriosa* sp. nov.

(Pl. XXXVI, Figs. 7, 8; Text-figs. 4-6)

A single specimen of this interesting Stylochid was collected by Mr. Baba under a stone at Oniike near Tomioka in spring of 1937.

The oval body measures 34 mm long by 22 mm broad, of a very firm consistency and is uniformly brown in color.

At the level of the first seventh of the body lie a pair of conical tentacles which are retractile within deep sheaths. In the tentacle as well as at its base are found a large number of tentacular ocelli. Numerous cerebral eyes are arranged in two elongated clusters on either side of the mid line. Along the whole body margin are many irregular rows of marginal eyes which are more densely set in the anterior body-half.

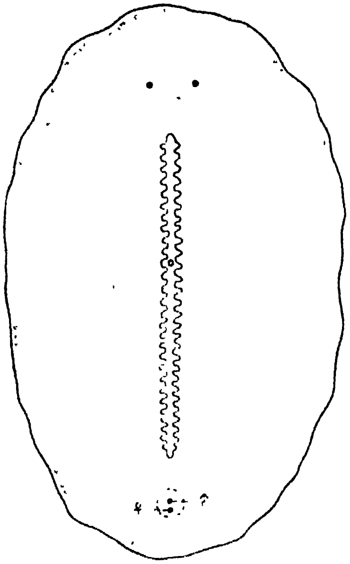


Fig. 4. *Kaburakia gloriosa.* ×2.

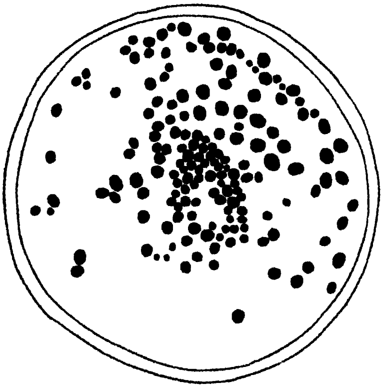


Fig. 5. *Kaburakia gloriosa*; tentacular eyes. ×55.

The dorsal epidermis is twice as thick as the ventral one and is crowded with an eosinophilous granular secretion. I can find no trace of rhabdites. The dermal musculature is well developed. The dorsal side consists of a thin, outer circular layer, followed by a thick longitudinal and a diagonal layer, and an innermost strongly developed circular layer; the ventral side is composed of a thin, outer circular layer, next to a diagonal, followed by a circular layer and an innermost longitudinal layer. The dorso-ventral muscle fibers are also well developed.

The pharynx is very narrow and long as diagrammatically shown in Fig. 4, and excessively folded. The mouth opening lies near the center of the body.

Near the posterior end of the body there is a large, flatly conical process on the ventral side, inside this process lie the main parts of the reproductive organs. The seminal canals, running posteriorly on either side of the pharyngeal chamber, converge to the process mentioned above, where, they expand each into a long, tubular false seminal vesicle with a thick muscular wall. The seminal vesicle proceeds dorsad and suddenly turns medio-ventrally, and unites with the duct from the other side to make a single ejaculatory duct which is also coated with a thick muscular wall. It runs posteriad for a short distance along the ventral side and joins with the duct of the prostate vesicle to open at the tip of the penis. The prostate vesicle of this species resembles well that of the members of *Stylochus*. It is a large, elongate oval body with a thick muscular coating and is lined with a richly folded epithelium which forms a large number of radial chambers arranged rather irregularly. The extracapsular prostate glands are well developed. The penis is very small and lacks a chitinous stylet. The antrum masculinum is amply wide and opens to the exterior by a minute pore.

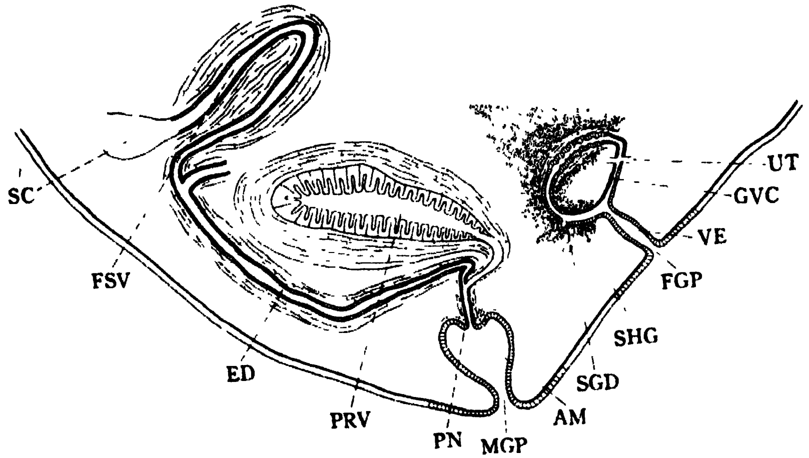


Fig. 6. *Kaburakia gloriosa*; sagittal section through genital organs. ×35.

A short distance posterior to the male genital pore is situated the female orifice which upwardly leads into a cylindrical vagina externa. The latter soon bifurcates into two canals; the one directed anteriad is the shell gland duct and the other directed posteriad is the genito-vaginal canal. The shell gland duct, taking posteriorly a semi-circular course, leads into the vagina interna which, after receiving paired uteri, instead of a single common uterine duct, continues to the genito-vaginal canal given above. The epithelium of the terminal portion of the shell gland duct assumes a spiral arrangement. The shell gland is strongly developed.

The present worm is somewhat related to *Cryptophallus* in the presence of the genito-vaginal canal which opens to the vagina externa itself. However, judging from the possession of distinct tentacles and a horizontally situated, large-chambered prostate vesicle, I consider it is to be referable to *Kaburakia* which has been represented by a single species *excelsa* (Bock, 1925) from the coast of North America. In *excelsa*, the genito-vaginal canal opens to the exterior slightly behind the female genital aperture. This interesting Stylochid seems to be an intermediate form between *Kaburakia* and *Cryptophallus*.

4. *Cryptocelis amakusaensis* Kato

Cryptocelis amakusaensis Kato, 1936, pp. 17–20.

This species is very common on a muddy beach in the vicinity of the laboratory and attacks the living periwinkle, *Umbonium moniliferum.*

5. *Notoplana humilis* (Stimpson)

Leptoplana humilis Stimpson, 1857, p. 9.

Notoplana humilis (Stimpson) Yeri et Kaburaki, 1918, pp. 11–13.

Very common in this district.

6. *Notoplana delicata* Yeri et Kaburaki

Notoplana delicata Yeri et Kaburaki, 1918, pp. 13–15.

This species is also fairly common.

7. *Notoplana serica* sp. nov.

(Pl. XXXVII, Figs. 1–3; Text-figs. 7, 8)

This species is based on a single specimen found adhering to the underside of a stone near the low tidemark at Siroiwa-zaki.

The animal is of an elongated shape with a broadly rounded anterior end and a bluntly pointed posterior extremity, measuring 22 mm in length and 6 mm in breadth. The color of the dorsal surface is translucent white with a large number of minute light brown pigments. Numerous ovaries are seen as white dots in the living state.

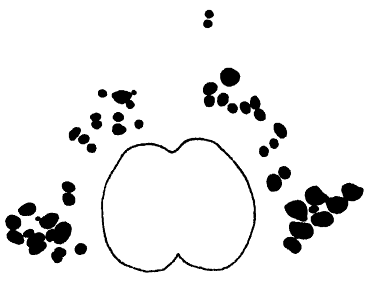


Fig. 7. *Notoplana serica*; arrangement of eyes. ×55.

No tentacle is observed, but the tentacular groups of eyes are present on either side of a large brain at the hind level of the first seventh of the body. Both the tentacular and cerebral eyes, as shown in Fig. 7, are very small in number. The mouth holds a position at the posterior limit of the first third of the body and the plicated pharynx occupies one-fifth the body-length.

The male and the female genital pore are closely applied, lying near the center of the body. The seminal vesicle is ovoid in shape with a thick muscular wall and receives a pair of the seminal canals from ventrad. Issuing from the postero-dorsal corner of the vesicle, the ejaculatory duct soon merges into the prostate vesicle to pierce it in its lower part. The prostate vesicle is also an oval body with a muscular coating, consisting of a few glandular sacks and opens into the ejaculatory duct at the outset of the prostate vesicle. It is abundantly supplied with extracapsular glands. The penis is represented by a long chitinous stylet which is disposed in a curved state in the deeply narrow antrum.

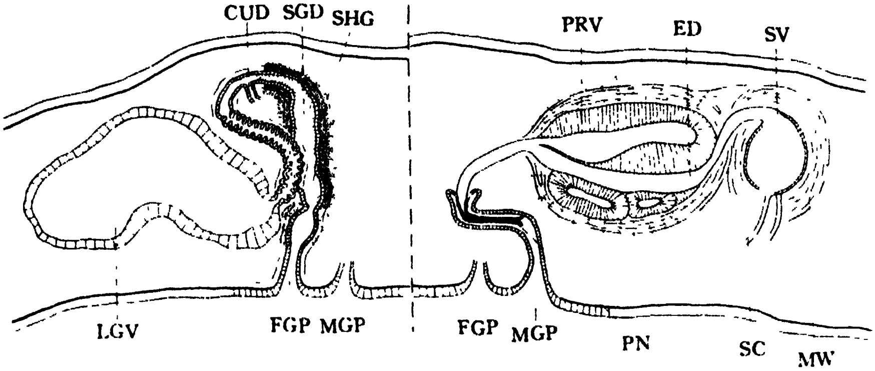


Fig. 8. *Notoplana serica*; sagittal section through genital organs. ×55.

The female genital pore lies directly behind the male pore and leads upwardly into the vagina externa. The dorsal portion of the vagina externa is a little enlarged to form a pouch, into which is discharged a faintly eosinophilous fine secretion carried from the glands scattered in the parenchyma around the pouch. The shell gland duct runs dorso-laterally to near the dermal musculature and passes into a short vagina interna which receives on its ventral side the common duct from the two uteri, and continues to the moniliform duct of the Lang's glandular vesicle. The Lang's vesicle is very large and is situated closely behind the level of the female pore. The shell gland duct is lined with a conspicuously ciliated epithelium and receives a large quantity of spindle-shaped secretion granules of the shell gland.

The present animal is easily distinguished from all other species of this genus by the unique structure and arrangement of the reproductive organs.

8. *Hoploplana ornata* Yeri et Kaburaki

Hoploplana ornata Yeri et Kaburaki, 1918, pp. 15-17; Bock, 1924, p. 22.

This splendid *Hoploplana* is commonly found on the undersurface of stones between the tidemarks at Zuirin-ji.

9. *Planocera reticulata* (Stimpson)

Planocera reticulata (Stimpson) Yeri et Kaburaki, 1918, pp. 19–22.

This species is very common in this district.

10. *Pseudostylochus obscurus* (Stimpson)

Stylochus obscurus Stimpson, 1857, p. 11.

Pseudostylochus obscurus (Stimpson) Yeri et Kaburaki, 1918, pp. 30–31.

Numerous specimens were collected at Oniike.

11. *Pseudostylochus meridialis* sp. nov.

(Pl. XXXVI, Figs. 3, 4; Text-figs. 9, 10)

Two specimens were collected under stones in a muddy beach near Zuirin-ji.

This elonagted Pseudostylochid somewhat resembles *Pseudostylochus elongatus* (Kato, 1937 a) in its body shape as well as its color markings, viz., the ground color of the dorsal surface is translucent milky white, over which are scattered yellowish brown spots and darker along the median line. It measures 22 mm in length and 6 mm in breadth.

At the level of the first fifth of the body lie the tentacles which are represented by slight elevations of the epidermis. The arrangement of the eyes is shown in Fig. 9. The mouth is situated at the posterior border of the fourth-ninth from the anterior end and opens into the plicated pharynx which is about one-fifth the body-length.

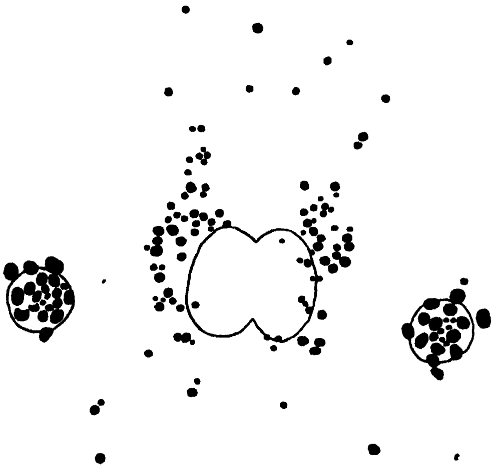


Fig. 9. *Pseudostylochus meridialis*; arrangement of eyes. ×50.

Immediately behind the posterior end of the pharyngeal chamber, the seminal canals unite into a single duct which is expanded very much with a large mass of spermatozoa. This widened duct opens antero-dorsally into the seminal vesicle by a narrow canal. The vesicle is large, provided with a thick muscular wall and tapers posteriad to form a narrow ejaculatory duct, which pursues a backward course in close contact with

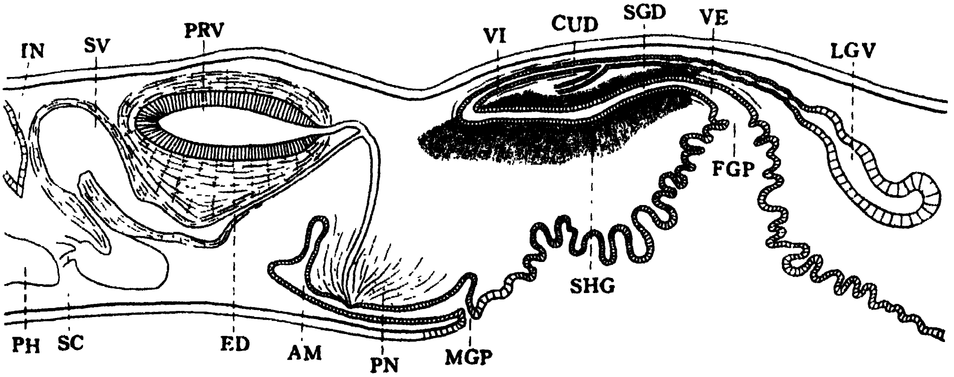


Fig. 10. *Pseudostylochus meridialis*; sagittal section through genital organs. ×50.

the ventral muscular wall of the prostate vesicle to join with its duct. The prostate vesicle is a relatively large, ovoid body and is not divided into chambers. Its muscular wall is well developed, especially more powerful on the ventral side than the dorsal. The penis, resembling that of *P. okudai* (Kato, 1937 b), is a large and flatly conical one. The male gonopore occurs near the posterior end of the antrum and at the anterior limit of the fourth-ninth of the body from the posterior end.

The arrangement of the female genital organs is quite in accord with that of *okudai* and *maculatus*. The sucking structure is well developed around the female aperture. The Lang's glandular vesicle is moderately large.

Of eleven species of *Pseudostylochus*, this flatworm somewhat resembles *P. elongatus*, *okudai* and *maculatus*. It is, however, easily distinguished from *elongatus* by the structure of the reproductive organs, and from the other two species by the body shape as well as the structure of the prostate vesicle and the penis.

12. *Cestoplana marina* sp. nov.

(Pl. XXXVII, Figs. 6–8; Text-figs. 11, 12)

A single representative of this species was taken under a stone at the low tidemark at Ebisu-zaki.

The living animal is of an elongated band-like shape with a bluntly pointed anterior end, measuring 70 mm in length. The posterior body-half is highly contracted in a resting state. The body color is an opaque white without markings as in *Cestoplana lactea* (Kato, 1937 a).

Numerous eye-spots are distributed all over the head, in front of the level of the brain. Among the eye-spots, those arranged from either side of the brain toward anteriad are smaller in size than the others and apparently represent the cerebral groups. The mouth is situated near the posterior end of the short plicated pharynx which lies, as usual, near the hind end of the body.

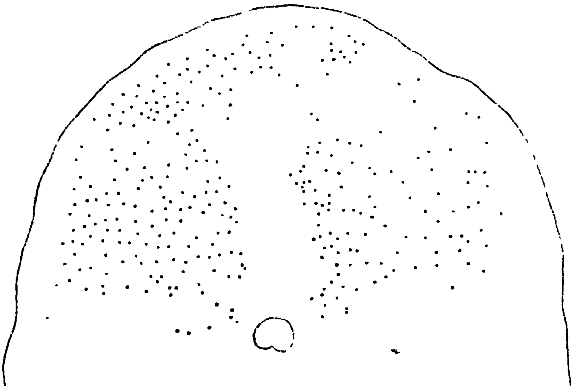


Fig. 11. *Cestoplana marina*; arrangement of eyes. ×22.

The structure of the male and female genital organs resembles well that of *lactea* as shown in Fig. 12. The present planarian, however, is provided with a single male genital system, while *lactea* possesses the duplicate male genital organs. Moreover, in this species, the seminal canals unite into a single duct before entering the seminal vesicle and the sucker is totally lacking (*cf. lactea*).

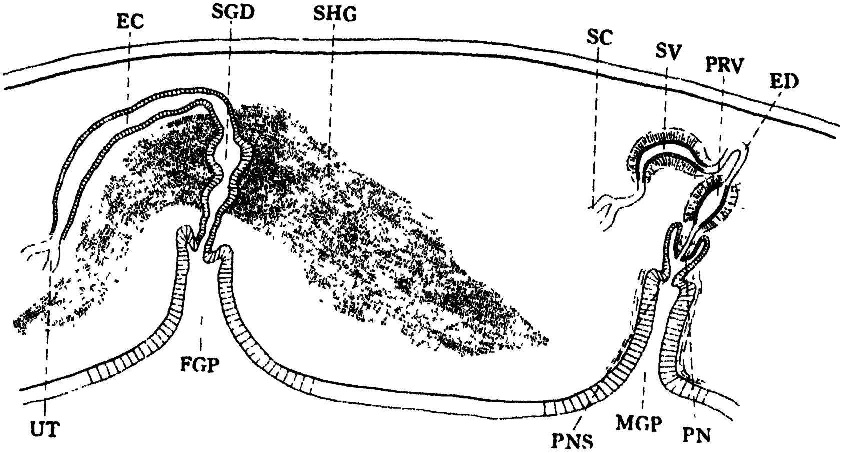


Fig. 12. *Cestoplana marina;* sagittal section through genital organs. ×70

13. *Pseudoceros atropurpureus* Kato

Pseudoceros atropurpureus Kato, 1934, pp. 129-130.

Several specimens of this species were collected at Oniike. The animal in this locality is more blackish violet on the dorsal surface, and uniformly distributed white dots are larger than those of the Susaki form. The seminal canal of the left side does not form a loop in front of its opening into the seminal vesicle (*cf.* Kato, 1934, p. 129).

14. *Pseudoceros tomiokaensis* sp. nov.

(Pl. XXXVII, Fig. 9; Text-figs. 13-15)

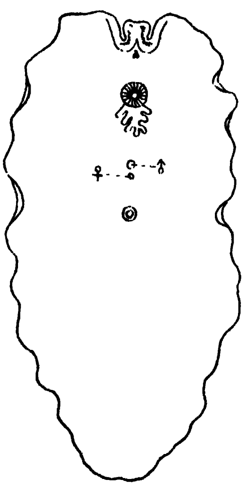


Fig. 13. *Pseudoceros tomiokaensis.* ×3.

Two individuals of this species were found in the preserved specimens of the laboratory. They were collected on *Gelidium* in Tomioka Bay on July 2, 1933.

The body is elongate oval in shape, the anterior end being broader than the posterior and with a very frilled margin. It measures 20 mm long by 13 mm broad. The color is almost gone.

The anterior end of the body is deeply folded to form a pair of marginal tentacles. A large number of eye-spots are arranged in regular rows along the margin of the tentacular folds, and a cluster of cerebral eyes lies at the base of the folds. The mouth is situated at the hind end of the first fifth of the body. The pharynx is comparatively short, bearing glove-shaped folds. The intestinal branches make a network. The sucker lies a little in front of the middle of the body.

The female genital organs are not yet developed. The male organs are quite similar to the general plan of this genus as shown in Fig. 15. The male pore occurs slightly in front of the posterior end of the first third of the body and the female pore a little behind the male one. This species is characterized by the conspicuous arrangement of the eyes.

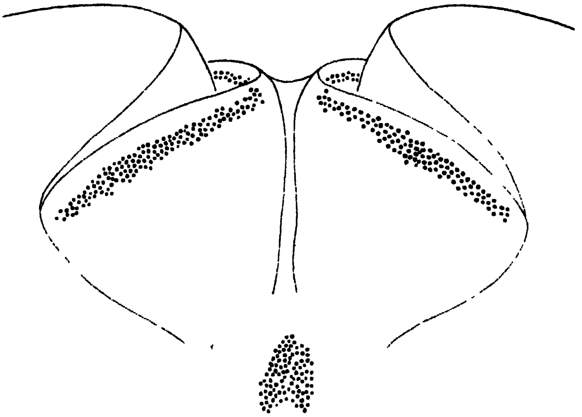


Fig. 14. *Pseudoceros tomiokaensis*; arrangement of eyes ×22.

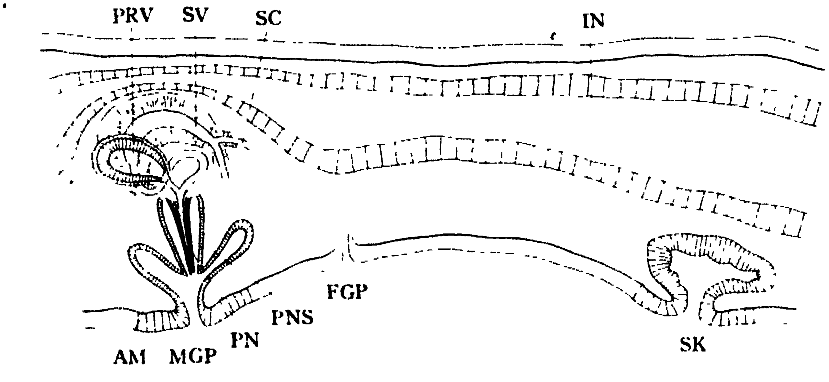


Fig. 15. *Pseudoceros tomiokaensis*; sagittal section through genital organs. ×35.

15. *Pseudoceros memoralis* sp. nov.

(Text-figs. 16–18)

This new *Pseudoceros* is represented by two individuals living on the undersurface of stones below the medium tidemark at Tusi-jima.

The body is oval in shape with a frilled margin, of a delicate consistency, and measures about 30 mm long by 20 mm broad. The dorsal surface is of a fleshy white color with a number of minute dark dots, and is margined all around by three bands of different colors, an outer narrow emerald green, a middle wide black and an inner wide yellowish brown. The two inner bands are numerously interrupted by narrow milky white lines.

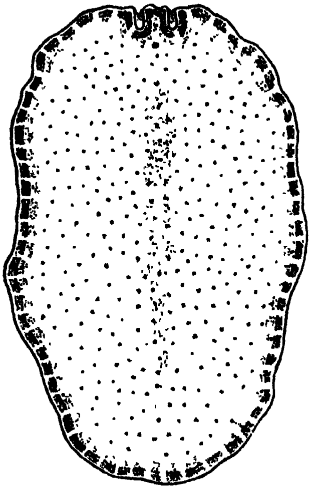


Fig. 16. *Pseudoceros memoralis.* ×2.

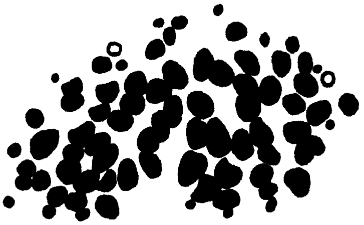


Fig. 17. *Pseudoceros memoralis;* cerebral eyes. ×55.

The frontal margin gives rise to a couple of tentacular folds. The cerebral eyes are vaguely separated into two lateral halves by the median line. A pair of ventral eyes are present. The intestinal and the genital system of this species are closely similar to those found in other species of the genus. The sucker occurs near the middle of the body, and the male and female genital pores lie, as usual, between the sucker and the posterior end of the pharynx.

This species can be distinguished from the known members of the genus by its conspicuous color markings.

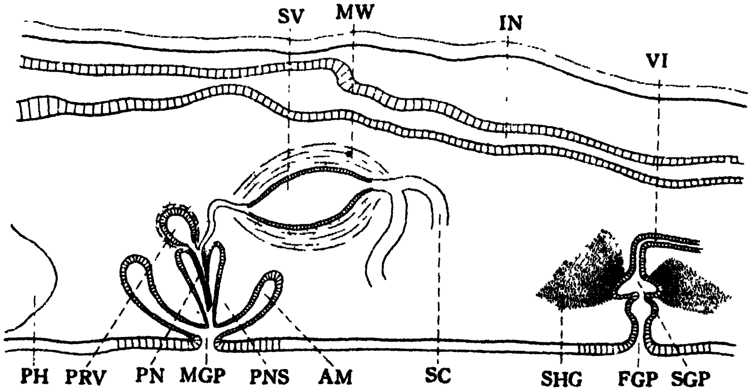


Fig. 18. *Pseudoceros memoralis;* sagittal section through genital organs. ×55.

16. *Pseudoceros pius* sp. nov.

(Text-figs. 19–21)

This new species is based on a single specimen collected at Siroiwa-zaki.

The body is thin leaf-like in shape and of a sinuous outline. The tentacles appear as two short folds of the frontal margin of the body. The fully expanded animal measures 15 mm in length and 9 mm in breadth. The dorsal surface is light yellow, covered with a dense reticulation of minute red and blackish purple pigment granules, and is darker along the median line. In addition, many large blackish purple spots are uniformly distributed over the reticulation. Numerous eye-spots are scattered over each tentacular fold, and the tentacular group of eyes, divisible into two closely approximated clusters, occur dorsad to the brain. The mouth lying, as usual, immediately behind the cerebral eyes, leads into a short plicated pharynx. The sucker is nearly in the center of the body.

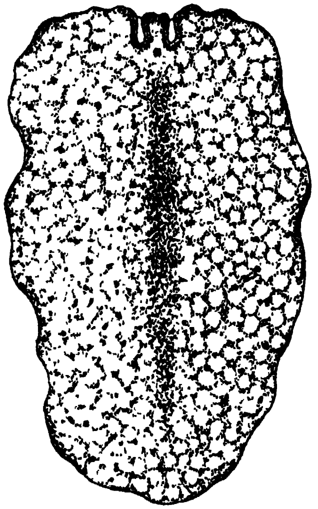


Fig. 19. *Pseudoceros pius*. × 1.

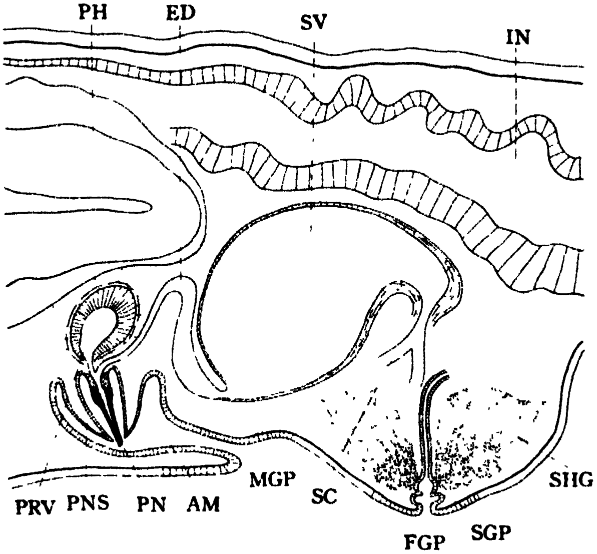


Fig. 21. *Pseudoceros pius*; sagittal section through genital organs. ×55.

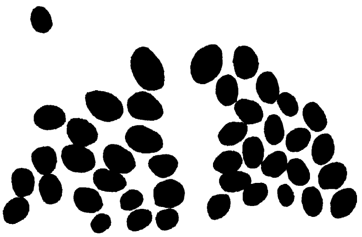


Fig. 20. *Pseudoceros pius*; cerebral eyes. ×55.

The genital organs are the common *Pseudoceros*-type, but they take a characteristic arrangement as shown in Fig. 21. The seminal vesicle is very large and is surrounded with a thin muscular wall. The male and the female gonopore, slightly apart from each other, lie at the level directly behind the posterior end of the pharynx.

17. *Cycloporus papillosus* (M. Sars)

Cycloporus papillosus Lang, 1884, pp. 568–571.

Cycloporus papillosus (M. Sars) Bock, 1913, pp. 262–264; Yeri et Kaburaki, 1918, pp. 40–41; Kato, 1937 a, pp. 229–230.

Two specimens of ***C. papillosus*** var. ***misakiensis*** were obtained at Siroiwazaki.

18. *Prosthiostomum grande* Stimpson

Prosthiostomum grande Stimpson, 1857, p. 10; Yeri et Kaburaki, 1918, pp. 42–43.

Two specimens were collected at Oniike.

19. *Prosthiostomum auratum* Kato

Prosthiostomum auratum Kato, 1937 d, pp. 363–364.

A single specimen referable to this species was found at Zuirin-ji.

20. *Prosthiostomum vulgaris* Kato

Prosthiostomum vulgaris Kato, 1938 pp. 588.

This widely distributed *Prosthiostomum* was also collected in Tomioka.

21. *Prosthiostomum sonorum* sp. nov.

(Pl. XXXVI, Figs. 5, 6; Text-figs. 22, 23)

A single specimen of this species was collected by the dredge along with some corals from a depth of 10 fathoms off Tomoe-zaki.

The body is of a typical Prosthiostomid-type, measuring 20 mm long by 2 mm broad. The color of the dorsal surface is translucent white covered with brown mottles, a number of which aggregate along the median line to form a brown stripe. The cerebral group of eyes, consisting of about 40 ocelli with a pair of ventral eyes, take a specific arrangement as shown in Fig. 22. They are indistinctly separated into two clusters by the median line. The marginal eyes occur irregularly along the frontal border and a few of them lying in the lateral parts, are larger in size than the others. The mouth lies immediately behind the brain, and leads into a long cylindrical pharynx. The anterior median branch of the intestine runs over the pharynx toward the cerebral region. The sucker is situated nearly in the middle of the body.

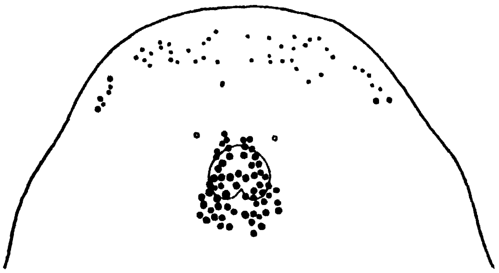


Fig. 22. *Prosthiostomum sonorum*; arrangement of eyes. ×20.

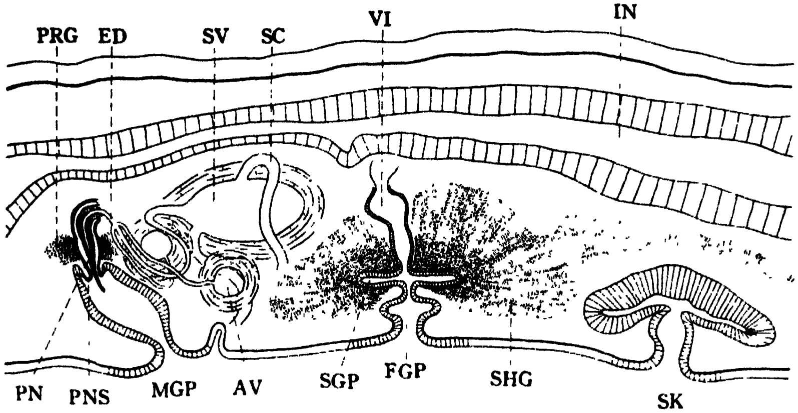


Fig 23. *Prosthiostomum sonorum*; sagittal section through genital organs. ×55.

The male genital aperture is situated directly behind the posterior end of the pharynx and at the hind level of the second fifth of the body from the anterior extremity. The female gonopore lies a little posterior to the male pore. The reproductive organs of this animal are in the same plan as in other species of this genus.

22. *Amakusaplana ohshimai* gen. et sp. nov.

(Pl. XXXVII, Figs. 4, 5; Text-figs. 24-26)

Two individuals which seem to represent a new genus and species were taken on Madreporarians at Magari-zaki.

The animal in life is elonagated oval in form, the anterior end being slightly broader than the posterior. The frontal margin of the body is a little depressed in the median line as in *Acerotisa baeckstroemi* (Bock, 1923). The body is very thin, of a delicate consistency and measures 15 mm in length by 6.5 mm in breadth. The dorsal surface is milky white and the intestine is light brownish red. A small brain lies at the first tenth of the body, and immediately behind it, the mouth leads into a short, cylindrical pharynx. The main intestine runs along the median line and bears numerous lateral branches, which do not show any anastomoses. A median branch of the intestine runs anteriorly over the pharynx.

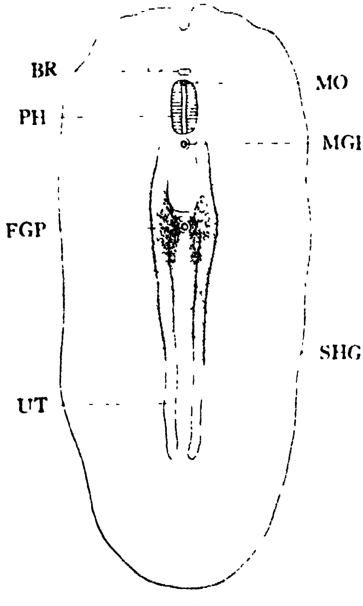


Fig. 24. *Amakusaplana ohshimai*. ×5.

The eye-spots are scattered in the frontal end of the body, chiefly in front of the level of the brain, and some occur on either side of the anterior half of the pharynx. It is hardly possible to distinguish the eye-spots into the marginal, cerebral and frontal groups.

So far as my observation goes, the present species appears to be devoid of any ventral sucking disc.

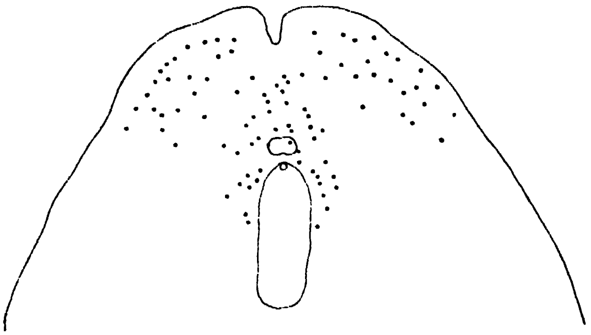


Fig. 25. *Amakusaplana ohshimai*; arrangement of eyes. ×18.

The epidermis, consisting of columnar cells, is higher on the dorsal than on the ventral side. The rhabdites abundantly occur in the dorsal epidermis and very scarce in the ventral one. The dermal musculature is poorly developed.

The general plan of the genital system is quite in accord with that of ***Prosthiostomum*** as shown in Fig. 26. The small seminal vesicle is coated with a strongly developed muscular wall. A pair of the seminal canals make each its way into the vesicle at its anterior aspects. From the antero-dorsal part of the vesicle is issued an ejaculatory duct, full of sperms, which extends for a long distance to open at the tip of the pointed penial stylet. The paired accessory vesicles open by each narrow canal into the ejaculatory duct some way before entering the penis. A large amount of prostatic secretion empties into the lower half of the penis sheath. The antrum masculinum is wide and deep, opening to the exterior immediately behind the pharynx and a little posterior to the hind limit of the first fifth of the body.

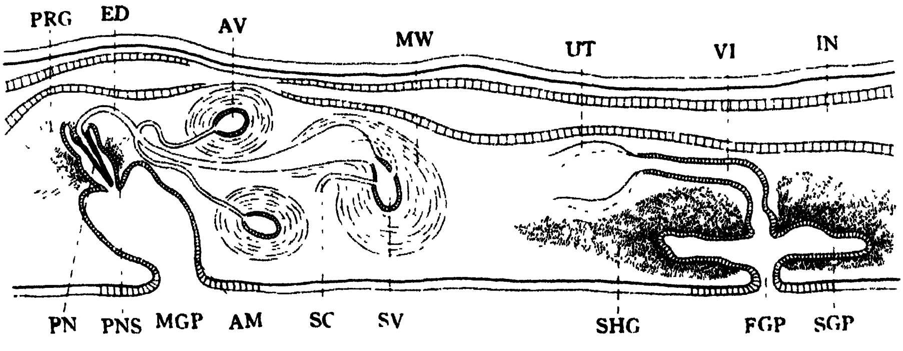


Fig. 26. *Amakusaplana ohshimai*; sagittal section through genital organs. ×50.

The female genital pore is widely separated from the male one. The shell gland pouch is flat and large. The egg canal turns anteriad to receive two uteri, each of which soon bifurcates into an anterior and a posterior branch. The shell gland secretion is of a spindle shape.

Judging from the features given above, this polyclad, in spite of the total destitute of the sucker, without doubt belongs to the cotylean family Prosthiostomidae, in which are included three genus, *Prosthiostomum*, *Euprosthiostomum* and *Enchiridium*. The species in question is fundamentally different from the members of those genus in the body shape and the arrangement of the eyes. I wish, here, to erect for this worm a new genus *Amakusaplana* under the following diagnosis.

" Prosthiostomid with a thin, elongate oval body, with a slight median depression at the frontal end. The eyes are irregularly scattered in the anterior end of the body, not forming such special groups as the cerebral, marginal or frontal ones. The mouth lies immediately behind the brain. The pharynx is cylindrical and short. Intestinal branches are not anastomosed. Without a sucker ".

By the way, such cotyleans as *Diplopharyngeata filiformis* (Plehn, 1896) and *Simpliciplana marginata* (Kaburaki, 1923) have been reported to be devoid of the sucker.

I take pleasure in naming this species in honor of Professor H. Ohshima.

LITERATURE

List of literature cited is appended to the subsequent paper.

EXPLANATION OF PALTES

ABBREVIATIONS

AM antrum masculinum; AV accessory vesicle; BR brain; CGA common genital atrium; CGP common genital pore; CUD common uterine duct; ED ejaculatory duct; FGP female genital pore; FSV false seminal vesicle; GVC genito-vaginal canal; IN intestine; LGV Lang's glandular vesicle; MGP male genital pore; MO mouth; MW muscular wall; PH pharynx; PN penis; PNS penis sheath; PRG prostate gland; PRV prostate vesicle; SC seminal canal; SGD shell gland duct; SGP shell gland pouch; SHG shell gland; SK sucker; SV seminal vesicle; UT uterus; VE vagina externa; VC vaginal canal; VI vagina interna; ♂ male genital pore; ♀ female genital pore

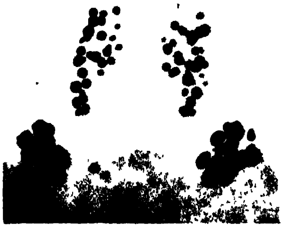
PLATE XXXVI

1. *Discocelis pusilla* sp. nov., eye-spots. ×40
2. Ditto, sagittal section through genital organs. ×57
3. *Pseudostylochus meridialis* sp. nov., anterior end of body. ×15
4. Ditto, sagittal section through genital organs. ×12
5. *Prosthiostomum sonorum* sp. nov., anterior end of body. ×15
6. Ditto, sagittal section through genital organs. ×40

7, 8. *Kaburakia gloriosa* sp. nov., sagittal section through genital organs. ×12

PLATE XXXVII

1. *Notoplana serica* sp. nov., anterior end of body. ×26
2, 3. Ditto, sagittal section through genital organs. ×40
4. *Amakusaplana ohshimai* gen. et sp. nov., anterior end of body. ×26
5. Ditto, sagittal section through genital organs. ×40
6. *Cestoplana marina* sp. nov., anterior end of body. ×26
7, 8. Ditto, sagittal section through genital organs. ×40
9. *Pseudoceros tomiokaensis* sp. nov., anterior end of body. ×26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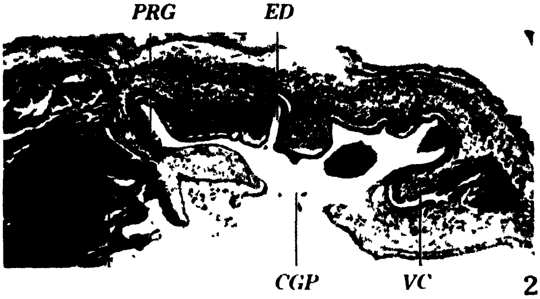
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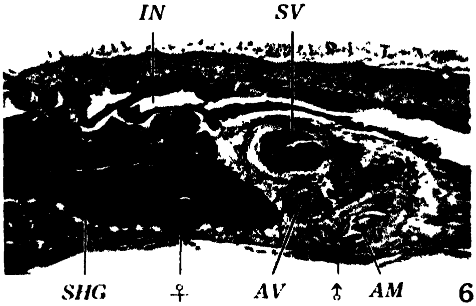
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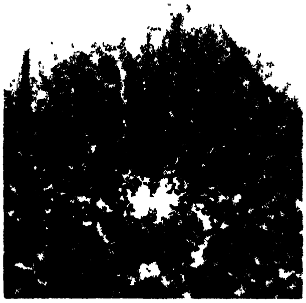
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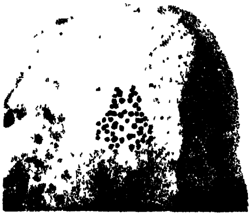
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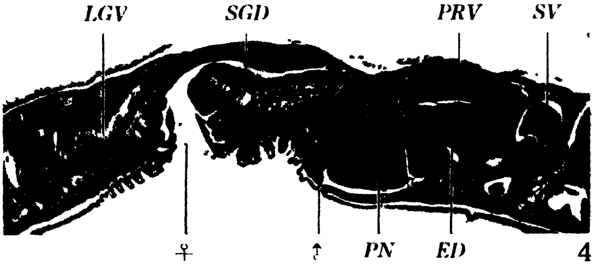
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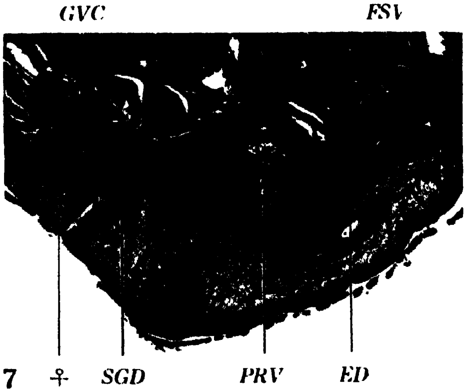
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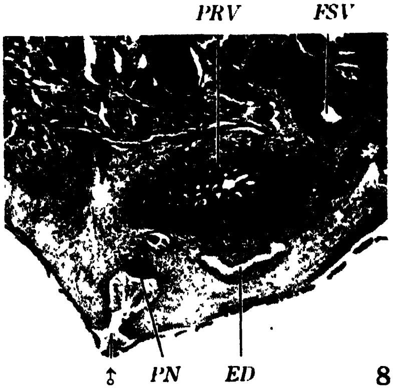
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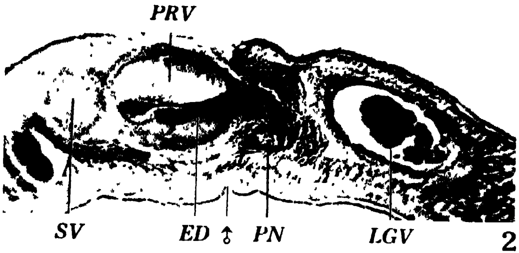

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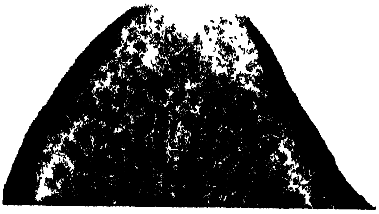

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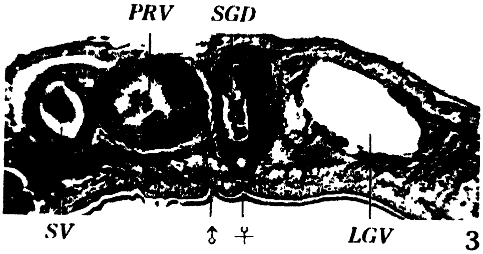

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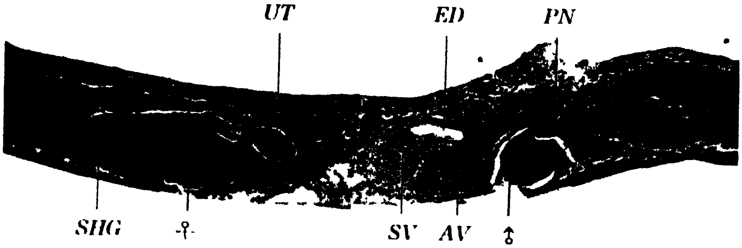

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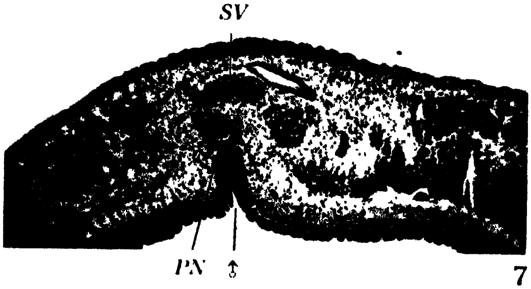

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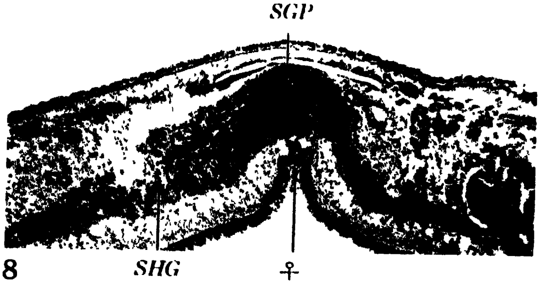

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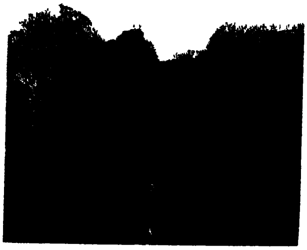

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26. Polyclads from Seto, Middle Japan.

By Kojiro KATO

Mitsui Institute of Marine Biology, Susaki near Simoda, Idu

(With 20 Text-figures and Plates XXXVIII-XXXIX)

The polyclads described in this paper were chiefly collected by the author in April, 1937, in the vicinity of the Seto Marine Biological Station at Seto, Wakayama Prefecture. Of the twenty-five species listed below, seven appear to be new.

Order Polycladida
  Suborder Acotylea
    A. Section Craspedommata
      Family Discocelidae
        1. *Discocelis japonica* Yeri et Kaburaki
      Family Stylochidae
        2. *Stylochus ijimai* Yeri et Kaburaki
        3. *Bergendalia mirabilis* sp. nov.
        4. *Cryptophallus sondaicus* Bock
    B. Section Schematommata
        5. *Notoplana humilis* (Stimpson)
        6. *Notoplana delicata* Yeri et Kaburaki
        7. *Notoplana japonica* Kato
        8. *Discoplana takewakii* Kato
        9. *Hoploplana cupida* sp. nov.
      Family Planoceridae
        10. *Planocera reticulata* (Stimpson)
      Family Diplosolenidae
        11. *Callioplana marginata* Stimpson
        12. *Pseudostylochus obscurus* (Stimpson)
        13. *Pseudostylochus elongatus* Kato
        14. *Pseudostylochus edurus* sp. nov.
        15. *Pseudostylochus maculatus* sp. nov.
    C. Section Emprosthommata
        16. *Cestoplana rubrocincta* (Grube)
  Suborder Cotylea
      Family Pseudoceridae
        17. *Pseudoceros atropurpureus* Kato
        18. *Pseudoceros exoptatus* sp. nov.
      Family Eureleptidae
        19. *Cycloporus papillosus* (M. Sars)
      Family Chromoplanidae

20. *Chromoplana bella* Bock

Family Prosthiostomidae

21. *Prosthiostomum grande* Stimpson
22. *Prosthiostomum marmoratum* Yeri et Kuburaki
23. *Prosthiostomum auratum* Kato
24. *Prosthiostomum valgaris* sp. nov.
25. *Prosthiostomum laetum* sp. nov.

Before proceeding further, I wish to express my sincere thanks to Prof. Dr. Yô K. Okada, director of the Seto Marine Biological Station, for the use of the laboratory. My deepest thanks are also due to Dr. D. Miyadi and Mr. F. Hiro for their courtesy rendered me during my stay at Seto. Further I wish to thank Dr. G. Dan for correction of the manuscript.

1. *Discocelis japonica* Yeri et Kaburaki

Discocelis japonica Yeri et Kaburaki, 1918, pp. 3–5; Kato, 1937 a, pp. 212–213.

Very common at Edura, Sakatahana, Tôsima and Yuzaki.

2. *Stylochus ijimai* Yeri et Kaburaki

Stylochus ijimai Yeri et Kaburaki, 1918. pp. 6–8.

The most common Stylochid which often attacks young oysters. Numerous specimens were collected at Edura, Daizyasima, Mori and Sakatahana.

3. *Bergendalia mirabilis* sp. nov.

(Figs. 1–3; Pl. XXXVIII, 1, 2.)[1]

This new species is based on a single specimen taken at Yuzaki under a stone slightly embedded in the sand near the low tidemark.

The body is elongated, almost uniformly broad for the most part, with bluntly pointed anterior and posterior extremities, and is moderately firm in consistency, It measures 35 mm long by 6 mm broad in the living state.

The dorsal surface is of a grayish buff-pinkish color with a reddish median streak which fades away toward the margin. The ventral side is paler in color.

Both the tentacles and the tentacular eyes are totally lacking. Numerous eyes are densely disposed in the entire frontal part of the body and the marginal eyes are arranged in rows along the whole margin of the body.

The epidermis is much thicker on the dorsal than on the ventral side and consists of columnar cells containing a large number of spindle-shaped rhabdites and a great quantity of basophilous secretory substance.

The dermal musculature of the dorsal side is composed of a thin circular muscle layer immediately beneath the basement membrane, an outer thick longitudinal, a middle diagonal and an inner circular layer. The ventral side consists of an outer longitudinal, a middle circular and an inner longitudinal layer. The dorso-ventral muscle fibers are poorly developed.

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[1] Abbreviations in this and subsequent figures see p. 592.

The mouth is somewhat anterior to the center of the body and leads into a pharyngeal chamber with numerous lobed diverticulae. The main intestine running along the median line is provided with numerous lateral branches which repeatedly ramify toward the periphery but do not show any anastomosis. In *Bergendalia diversa* (Yeri et Kaburaki, 1918) the lateral intestinal branches form a network.

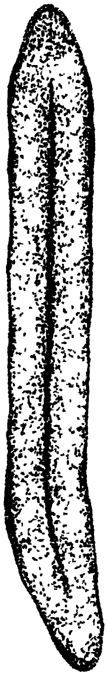

Fig. 1. *Bergendalia mirabilis.* ×2.5.

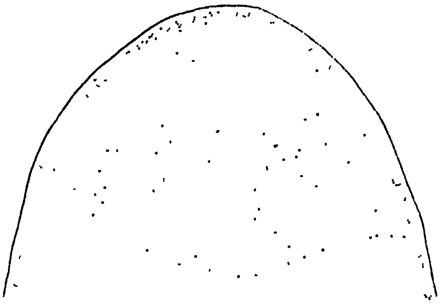

Fig. 2. *Bergendalia mirabilis*; arrangement of eyes. ×8.

The seminal canals, proceeding backward, turn dorso-mediad slightly behind the posterior end of the pharyngeal chamber to enlarge each into a tubular seminal vesicle with a thin muscular wall. The seminal vesicles narrow antero-mediad to unite into a single ejaculatory duct which soon joins, at a right angle, the duct from the prostate. The prostate vesicle is a horizontally situated, moderately large organ lined with cubical cells and is coated with a muscular wall, through which pierce numerous efferent ducts of the extracapsular glands. Arising from the distal end of the prostate, the relatively wide duct runs ventrad and after receiving the ejaculatory duct opens at the tip of the penis. The penis is small, conical and unarmed, vertically disposed in the cylindrical antrum which opens to the exterior by a small pore at the level between the last fourth and the last fifth of the body.

The female genital pore, situated a little behind the male pore, leads upwardly into the vagina externa which passes anteriorly into the shell gland duct. The internal epithelium of the terminal part of this duct assumes a spiral arrangement and into that portion empties a great amount of minutely granular shell secretion. The vagina interna turns posteriad and, receiving the common uterine duct, continues to the genito-vaginal canal which curves down to open to the exterior directly behind the female aperture. Just behind the genito-vaginal pore, two special post-genital glands are arranged in the median line. They are formed by the tubular infoldings of the ventral epidermis and are lined with cubical cells, receiving the eosinophilous secretion from the extracapsular glands.

Under the genus *Bergendalia* have been recorded two species, *anomala* (Laidlaw, 1903 a) from Penang and *diversa* from Japan. They are characterized by the possession of the duplicate male copulatory organs and are closely similar, except for the presence of eyes over the head-end surface and the fact that the duplicate penial organs are situated in front of, instead of behind, the functional penial organs. The present worm bears a certain resemblance to *diversa* in the arrangement of the eyes, but is distinguished from that and the another species by the total absence of the duplicate penial organs. The possession of the post-genital glands is also a characteristic feature of this species.

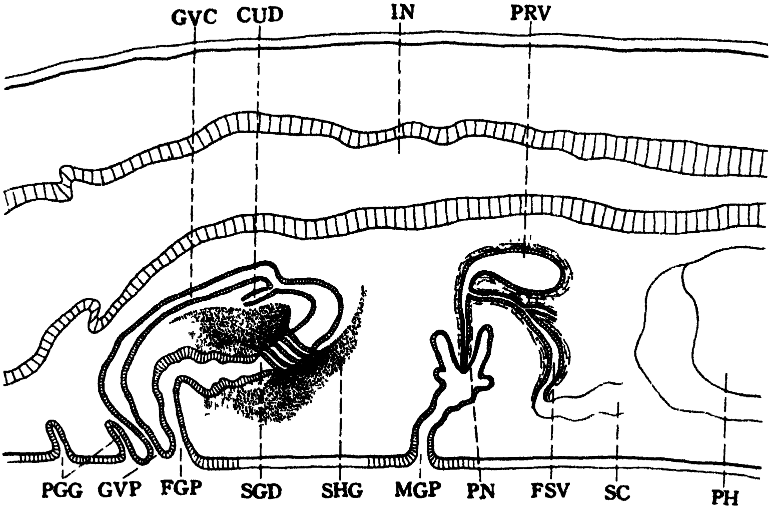

Fig. 3. *Bergendalia mirabilis*; sagittal section through genital organs. × 55.

The generic diagnosis of *Bergendalia* is amended as follows: " Stylochidae with elongate body, without tentacles and tentacular eyes. Marginal eyes are arranged along the whole body margin. With or without additional eyes distributed over the head end. Pharynx long, much folded and the mouth subcentral. With false seminal vesicles. Prostate vesicle is moderately large and horizontally situated. Penis unarmed. With or without duplicate penial system. With genito-vaginal canal which opens to the exterior immediately behind the female genital pore."

4. *Cryptophallus sondaicus* Bock

(Figs. 4-6; Pl. XXXVIII, 3, 4.)

Cryptophallus sondaicus Bock, 1925, pp. 120–132.

In the Museum of the Station was preserved a single specimen of *Cryptophallus* which had been obtained at Edura on Aug. 1, 1928.

The body is elongate oval in form, thick and of a firm consistency. The measurements of the specimen are as follows: The length of the body is 40 mm and the breadth 20 mm. From the tentacular eyes to the anterior end is 9 mm. From the mouth to the posterior end is 12 mm. The female genital pore is 4 mm from the posterior end. The male genital pore is 3.5 mm from the female, and 5 mm from the mouth.

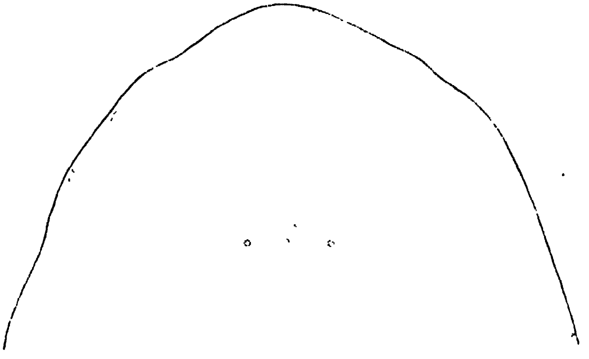

Fig. 4. *Cryptophallus sondaicus*; arrangement of eyes. ×3.5.

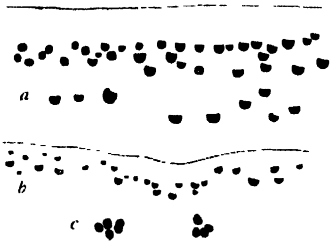

Fig. 5. *Cryptophallus sondaicus*; marginal (*a*, *b*) and tentacular eyes (*c*). ×50. *a*. At the anterior end. *b*. At the posterior end.

The color of the dorsal surface is light silvery black, darker along the median line, and the ventral side is almost colorless. Four or five tentacular ocelli are grouped at the base of the tentacles which are slight elevations of the epidermis. Along the whole margin of the body are arranged in a row the marginal eyes which are considerably larger in size than those of *Cryptophallus eximius* (Kato, 1937 a).

The male genital organs lie beneath the posterior end of the pharynx.

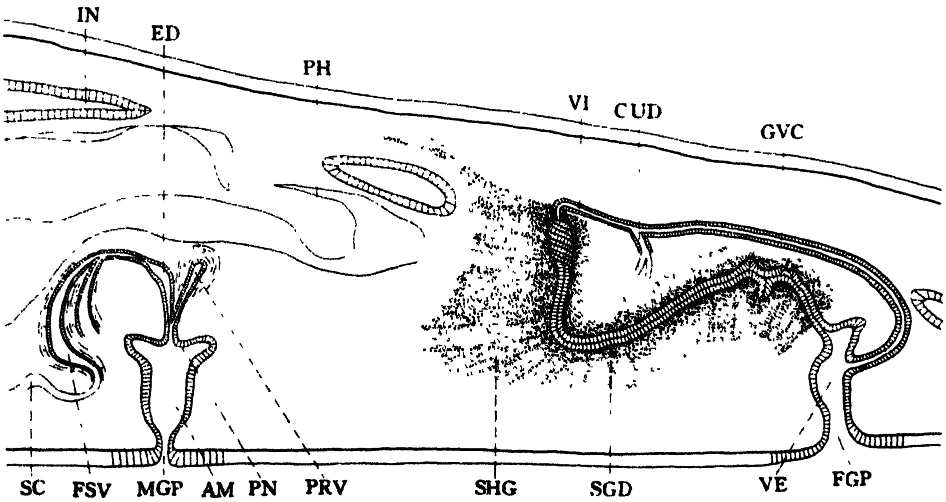

Fig. 6. *Cryptophallus sondaicus*; sagittal section through genital organs. ×30.

They consists of a wide antrum, a small, unarmed penis, a vertically placed, small prostate vesicle and a pair of tubular false seminal vesicles. The arrangement of the female genital organs is much similar to that found in the other species of this genus. The shell gland duct is extremely narrow and a part of the duct has a few twists.

The genus *Cryptophallus* contains three foreign species (*wahlbergi*, *sondaicus*, *bartschi*) and one Japanese form (*eximius*). The specimen from Seto is quite in accord with *sondaicus* from Amboina in its external and internal organizations except for the total absence of the rudimentary duct in connection with the ductus vaginalis. In spite of the conclusion of Meixner (1907, p. 144.) " So kommt es, dass nach unsern heutigen Kenntnissen jede Küstenpartie ihre besondere Stylochinen-Formen zu haben scheint.", I prefer to assign the Seto specimen for the present to *C. sondaicus*.

5. *Notoplana humilis* (Stimpson)

Leptoplana humilis Stimpson, 1857, p. 9.
Notoplana humilis (Stimpson) Yeri et Kaburaki, 1918, pp. 11–13.

The most common polyclad in the neighborhood of the Station.

6. *Notoplana delicata* Yeri et Kaburaki

Notoplana delicata Yeri et Kaburaki. 1918, pp. 13-15.

This species is also very common, like *N. humilis*.

7. *Notoplana japonica* Kato

Notoplana joponica Kato, 1937 a, pp. 215-216.

Five specimens referable to *Notoplana japonica* from Idu were collected at Yuzaki. This species is easily distinguished from *N. humilis* by its milky white color with a faint touch of pinkish brown and by the total absence of the tentacles.

8. *Discoplana takewakii* Kato

Discoplana takewakii Kato, 1935, pp. 149–157.

At Sakatahana, *Ophioplocus japonicus* was often found to be harbored in the genital bursa by this interesting planarian.

9. *Hoploplana cupida* sp. nov.

(Figs. 7, 8; Pl. XXXVIII, 5, 6.)

This species is based on a single specimen found at Tunasiradu.

The body is oval in shape with rounded anterior and posterior ends, thick and of a firm consistency, measuring 12 mm by 7 mm. The ground color of the dorsal surface is milky brown with minute brown speckles scattered all over it. The ventral side is milky white.

A pair of long tentacles are situated at a distance of 3 mm from the frontal end of the body. They are colorless. The tentacular eyes are numerous, grouped at the base of each tentacle. The cerebral eyes are very few in number, arranged on either side of the median line far in front of the level of the tentacles. The mouth is nearly in the center of the body.

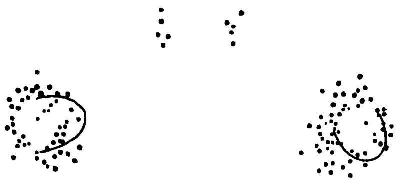

Fig. 7. *Hoploplana cupida*; arrangement of eyes. ×22.

The seminal canals, proceeding backward, expand each into a very large false seminal vesicle with a thin muscular wall. From the distal narrow end of the vesicle is sent off a slender duct which takes a tortuous course, and joins with the duct from the other side to make an ejaculatory duct. After a few turns the ejaculatory duct opens into the prostate vesicle, piercing through its muscular wall. The prostate vesicle is very small, pyriform in shape, provided with numerous extracapsular glands. The anterior end of the prostate tapers, to end in a curved, sharply pointed penial stylet. The antrum masculinum is cylindrical, wide and deep, and opens to the exterior by a minute pore at the anterior limit of the last fourth of the body. Both the antrum and the prostate are enclosed in a thick muscular wall.

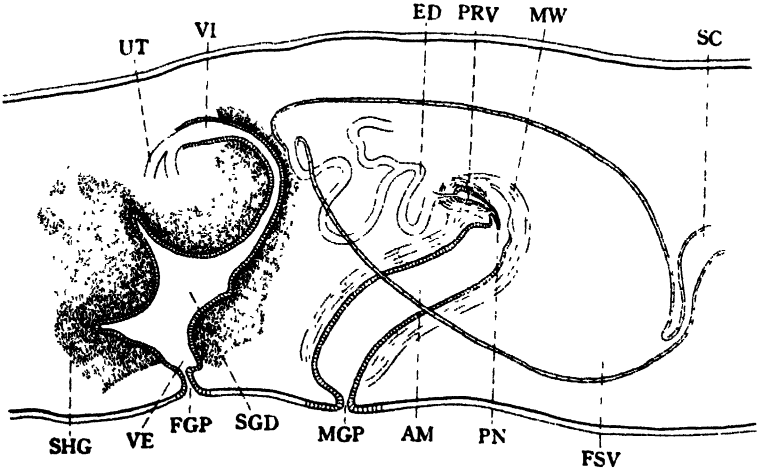

Fig. 8. *Hoploplana cupida*; sagittal section through genital organs. ×50.

The female genital aperture lies slightly behind the male pore. It leads into the ample vaginal cavity which narrows anteriorly and makes a dorsal turn to receive two uteri. Shell glands are enormously developed surrounding nearly the whole length of the vagina.

There have been recorded six species of *Hoploplana*, *i. e.*, *grubei*, *inquilina*, *insignis*, *ornata*, *papillosa* and *villosa*. The present animal is easily distinguished from them by the topography of the male genital organs.

10. *Planocera reticulata* (Stimpson)

Planocera reticulata (Stimpson), Yeri et Kaburaki, 1918, pp. 19–22.

This species is very common in this district.

11. *Callioplana marginata* Stimpson

Callioplana marginata Stimpson, 1857, p. 11; Yeri et Kaburaki, 1918, pp. 32–34.

This species is found in abundance at Yuzaki and at Tubaki near Seto.

12. *Pseudostylochus obscurus* (Stimpson)

Stylochus obscurus Stimpson, 1857, p. 11.

Pseudostylochus obscurus (Stimpson) Yeri et Kaburaki, 1918, pp. 30–31.

Three specimens of this species were found in the Museum of the Station. They were obtained at Tôsima on May 4, 1928.

13. *Pseudostylochus edurus* sp. nov.

(Figs. 9, 10; Pl. XXXVIII, 8.)

Two specimens of this species were obtained at Edura.

The body is elongate oval in shape with a rounded anterior and a bluntly pointed posterior extremity, measuring 20 mm long by 8 mm broad. The dorsal surface is covered with brown mottles on the light brownish green background and is darker along the median line.

A pair of small tentacles are situated at the posterior border of the first fifth of the body and each contains numerous eye-spots. The arrangement of the eyes is shown in Fig. 9. The mouth lies at the hind end of the second third of the body, leading into the pharyngeal chamber at its middle point.

The reproductive organs are of the typical Pseudostylochid-type. The seminal vesicle is moderately large with a thick muscular wall, lying a little behind the posterior end of the pharyngeal chamber, but not directly behind it. The prostate vesicle is a large ovoid body with a very thick muscular wall and consists of a few tubular glands. The penis is small, flatly conical in shape and is subvertically dis-

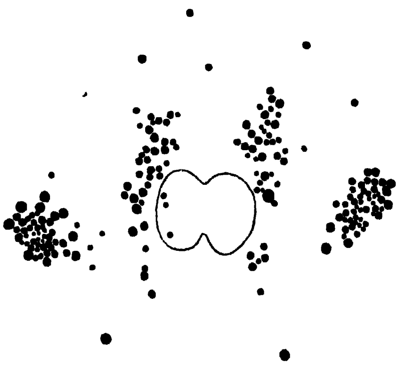

Fig. 9. *Pseudostylochus edurus*; arrangement of eyes. ×30.

posed in the antrum masculinum which opens to the exterior at the posterior limit of the third fifth of the body. Surrounding the male genital pore the parenchyma as well as the epidermis are slightly protruded. About 2.5 mm distant from the male pore lies the female aperture, surrounding which the sucking structure is developed as in *P. okudai*, *stimpsoni* and *aino*. The Lang's glandular vesicle is large and elongated, and the duct from it assumes a bead-like appearance.

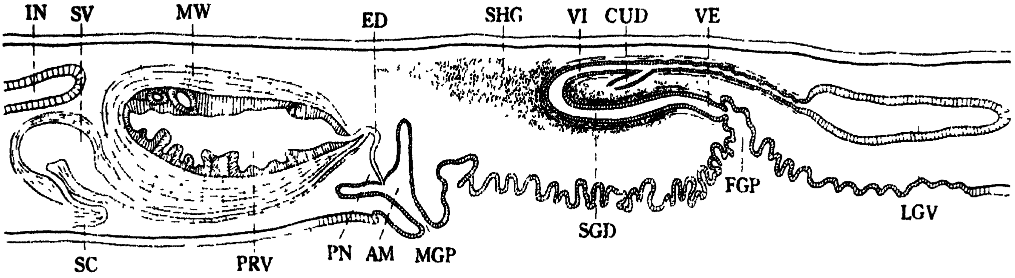

Fig. 10. *Pseudostylochus edurus*; sagittal section through genital organs. ×35.

In the general structure of the genital organs, this species is closely related to *aino* (Kato, 1937 c) from Hokkaidô. However, it differs from the latter in the possession of the large Lang's vesicle, a small penis and a large prostate vesicle.

15. *Pseudostylochus maculatus* sp. nov.

(Figs 11, 12; Pl XXXIX, 7.)

A single specimen of this new planarian was collected at Yuzaki.

The worm, in life, has a lengthened oval body, measuring 35 mm long by 14 mm broad. The dorsal surface is of a grayish green color variegated with dark yellowish- and greenish-brown maculae, and is darker along the the median line.

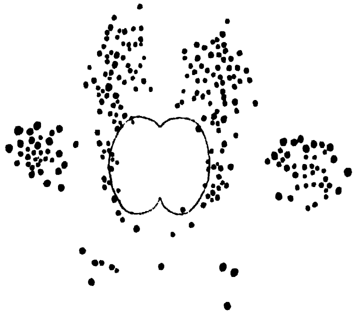

Fig. 11. *Pseudostylochus maculatus*; arrangement of eyes. ×25.

At the hind limit of the first fourth of the body lie a pair of very small tentacles which are slight elevations of the epidermis. The arrangement of the eyes is shown in Fig. 11. The mouth is located near the middle of the body. The pharynx is plicated, occupying three-sevenths the body length. The main intestine sends off about eight pairs of lateral branches.

The seminal canals run anteriad from near the posterior end of the body, turn backward at the level of the middle of the body and, proceeding postero-mediad, unite into a single duct on the ventral side of the body which abruptly opens into the seminal vesicle. The latter is

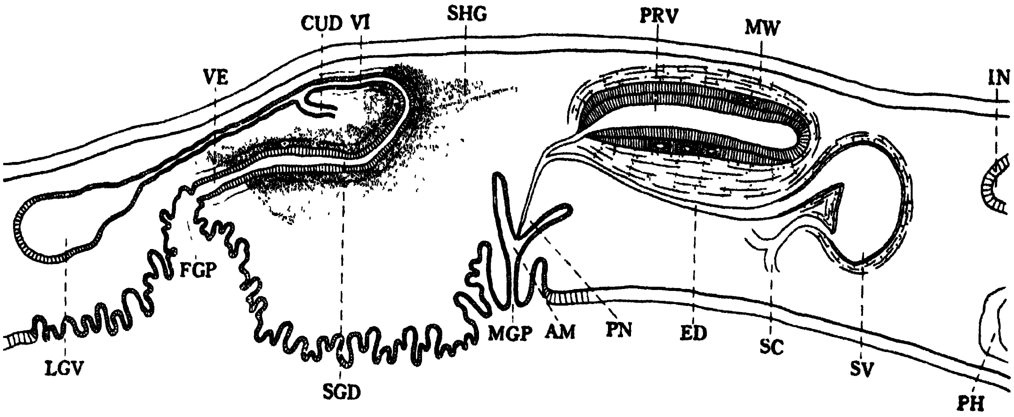

Fig. 12. *Pseudostylochus maculatus*; sagittal section through genital organs. ×30.

a relatively large, ovoid body lined with a flat epithelium and is surrounded with a muscular wall. The postero-dorsal part of the vesicle tapers backward to pass into the ejaculatory duct, which, skirting the ventral side of the prostate vesicle, runs for a long distance to join the duct from the prostate at the base of the penis. The prostate vesicle, placed on the dorsal side of the body, is a large elongate-ovoid body with a thick muscular wall, and its efferent duct, after receiving the ejaculatory duct, opens at the tip of a small conical penis. The penis totally lacks the chitinous stylet and hangs subvertically in the deep antrum which opens to the exterior at the posterior level of the fourth seventh of the body.

The female aperture is a little posterior to the male pore. The structure of the female genital organs is quite in accord with that of other species of this genus. The sucking structure is developed around the female pore.

This species can be distinguished from the known members of the genus by the dorsal position of the prostate vesicle, by the possession of the small conical penis, the small Lang's vesicle and the sucking structure of the female pore.

16. *Cestoplana rubrocincta* (Grube)

(Fig. 13)

Cestoplana rubrocincta (Grube) Lang, 1884, pp. 516–520; Kato, 1937 a, pp. 225–226.

Cestoplana filiformis Laidlaw, 1903 b, pp. 110–111.

Cestoplana australis Haswell, 1907, pp. 479–480.

This species is fairly common at Yuzaki and Edura. The largest specimen at my disposal is about 15 mm in length and 2 mm in breadth. The anterior end of the body is rounded as in *C. australis* of Haswell. The constriction found on the head of the Susaki specimen is probably an occasional one (Kato, 1937 a). The ground color of the dorsal surface is milky white with a faint touch of yellow, with three longitudinal reddish orange striations as shown in Fig. 13.

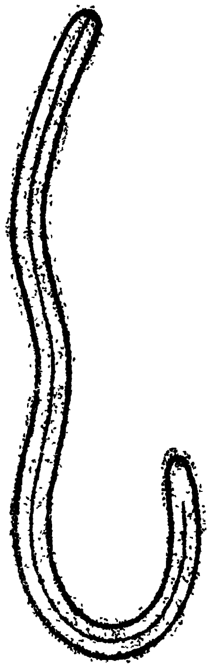

Fig. 13. *Cestoplana rubrocincta.* ×7.

17. *Pseudoceros atropurpureus* Kato

Pseudoceros atropurpureus Kato, 1934, pp. 129–130.

Very common at Yuzaki. This worm somewhat resembles *Pseudoceros velutinus* in its dark purplish color. The former, however, is easily distinguished from the latter by the presence of numerous minute white dots all over the dorsal surface.

18. *Pseudoceros exoptatus* sp. nov.

(Figs. 14, 15; Pl. XXXIX, 1, 2.)

A number of this species were collected at Sakatahana and Tunasiradu.

The body is oval in shape with a somewhat pointed posterior extremity and is of a delicate consistency. The margin of the body is very frilled. The larger specimens measure about 80 mm long by 40 mm broad. Along the median line the body is thickly elevated.

The color of the dorsal surface is light blackish violet and brownish along the median line, all over which are uniformly dispersed small white mottles. The body margin is of a dark purplish color. The ventral side is milky white.

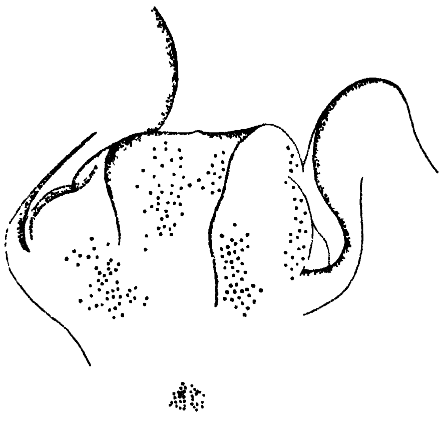

Fig. 14. *Pseudoceros exoptatus*; arrangement of eyes. ×17.

The marginal tentacles are deep folds of the anterior end of the body and on both the dorsal and ventral sides are scattered numerous eye-spots. At the base of the tentacular folds lies a cluster of cerebral eyes (about 30), which are indistinctly separated into two groups by the median line.

The mouth is located at the hind limit of the first eighth of the body. The main intestine runs along the median line to near the end of the body and is provided with numerous lateral branches which repeatedly ramify toward the periphery to form a network. The sucker is situated at the posterior extremity of the first third of the body. Between the mouth and the sucker occur the male and female genital pores in the middle line.

The seminal canals running anteriad turn dorso-mediad near the level of

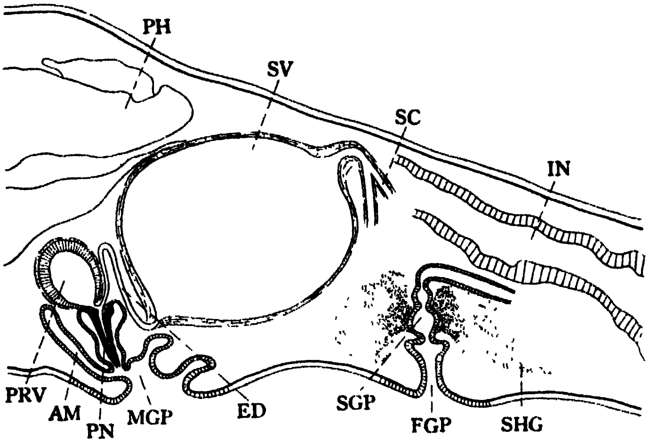

Fig. 15. *Pseudoceros exoptatus*; sagittal section through genital organs. ×17.

the female genital pore and unite into a single duct which opens directly into the large spherical seminal vesicle at its postero-dorsal aspect. From its antero-ventral part the narrow ejaculatory duct goes upward and then downward to open at the tip of the penial stylet. The small, spherical prostate vesicle tapers ventrally and soon makes its way to the ejaculatory duct at the base of the penis which is surrounded by the penis sheath.

A little behind the male genital pore lies the female pore. The antrum femininum passes into the shell gland pouch which continues to the egg canal. The shell gland secretion is abundant.

There have been recorded large numbers of *Pseudoceros* species, but so far as I can determine, my planarian resembles *P. sagamianus* (Kato, 1937 d) more closely than any other. However, it is distinguished from the latter by the structure of the male genital organs.

19. *Cycloporus papillosus* (M. Sars)

Cycloporus papillosus Lang, 1884, pp. 568–571.

Cycloporus papillosus (M. Sars) Bock, 1913, pp. 262-264; Yeri et Kaburaki, 1918, pp. 40–41; Kato, 1937 a, pp. 229–230.

A single specimen referable to *Cycloporus papillosus* var. *misakiensis* was collected under a stone near the low tidemark at Yuzaki.

20. *Chromoplana bella* Bock

(Fig. 16)

Chromoplanaa bella Bock, 1922, pp. 1–20.

Five specimens identical with *Chromoplana bella* from Misaki were collected under stones between the tidemarks at Yuzaki.

The animal is lancet shaped, measuring 8 mm in length. The dorsal surface is of a blackish brown color, provided with three white longitudinal streaks. The cerebral region and the frontal end of the body are also white. The ventral side is light brownish red in color. The marginal and the cerebral group of eyes each consists of two ocelli. A small sucker lies near the center of the body. As pointed out by Bock, the dorsal epidermis contains numerous nematocysts.

21. *Prosthiostomum grande* Stimpson

Prosthiostomum grande Stimpson, 1857, p. 10; Yeri et Kaburaki, 1918, pp. 42–43.

A fairly large number of this species were collected at Sakatahana and Tubaki.

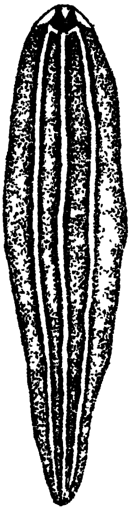

Fig. 16. *Chromoplana bella* ×8.

22. *Prosthiostomum marmoratum* Yeri et Kaburaki

Prosthiostomum marmoratum Yeri et Kaburaki, 1918, pp. 43-44.
Numerous specimens of this species were collected at Yuzaki.

23. *Prosthiostomum auratum* Kato

(Pl. XXXIX, 7.)

Prosthiostomum auratum Kato, 1937 d, pp. 363-364.

Numerous specimens referable to *P. auratum* from Idu were obtained under stones at Yuzaki and Sakatahana. The larger specimens measure 25 mm by 4 mm. This species is often found along with *Prosthiostomum vulgaris*, but is easily distinguished from it by its uniformly yellowish color with no spots or stripes, and by the arrangement of the eyes. In *auratum* the cylindrical pharynx is much shorter than that of *vulgaris*.

24. *Prosthiostomum vulgaris* sp. nov.

(Figs. 17, 18; Pl. XXXIX, 3, 4)

Numerous specimens of this species were collected at Yuzaki.

The body is very elongate with a rounded anterior end and a pointed posterior extremity, thin and delicate. A large specimen measures 25 mm in length and 3 mm in breadth.

The color of the body is light buffy, nearly cinnamon along the median line. In some specimens, minute white spots are scattered in great number in the median parts.

The cerebral eyes are arranged in two nearly linear groups, with a pair

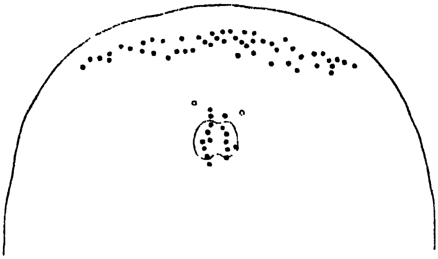

Fig. 17. *Prosthiostomum vulgaris*; arangement of eyes. ×22.

of ventral eyes. The marginal eyes are distributed along the frontal margin in irregular rows. The mouth lies immediately behind the brain and leads into the long cylindrical pharynx. The anterior median branch of the intestine runs for a short distance over the pharynx to end blindly. The sucker is located near the center of the body.

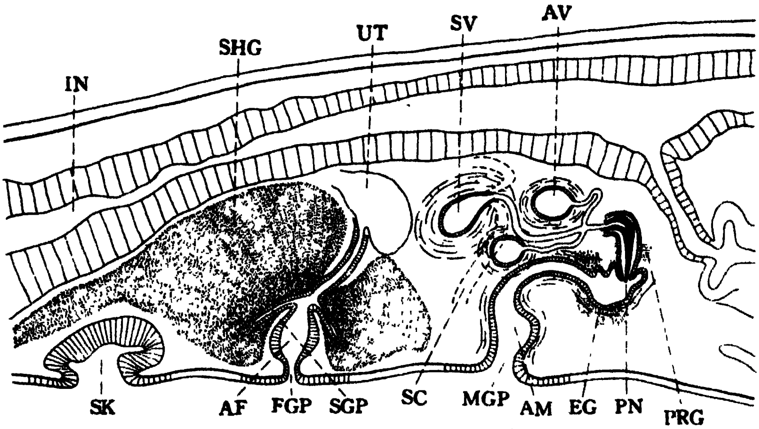

Fig. 18. *Prosthiostomum vulgaris*; sagittal section through genital organs. ×45.

This species is widely distributed along the Pacific coasts of Japan. Yeri and Kuburaki (1918) recorded this worm from Misaki, Matuwa and Sirahama, and referred it to the Mediterranean species *Prosthiostomum siphunculus*. However, after thorough studies on numerous specimens, I consider that this planarian represents a new species. The Japanese species is clearly distinguished from the Mediterranean by the total absence of the anterior median branch of the intestine, and in *vulgaris* the seminal canals open into the seminal vesicle at its anterior part near the ejaculatory duct, but in *siphunculus* the canals open at the posterior corner of the vesicle.

25. *Prosthiostomum laetum* sp. nov.

(Figs. 19, 20; Pl. XXXIX, 5, 6.)

This species is based on a single specimen collected by the dredge-net from a depth of about ten fathoms off Tonda near Seto.

The specimen was devoid of the posterior half of the body. It measures 4 mm from the frontal border of the body to the sucker and about 2 mm across the brain region. The anterior end of the body is slightly pointed. The color of the dorsal surface is light blackish green and the ventral side is paler.

The cerebral eyes, about 30 in number, are divided into two groups by the median line, and a pair of ventral ocelli lie on either side of the brain. The marginal eyes are few, arranged along the anterior end of the body. Almost all the ocelli are crescent or semicircular in shape.

The mouth is located directly beneath the cerebral eyes and leads into the cylindrical pharynx. The anterior median branch of the intestine runs for a short distance to end blindly. The sucker is small.

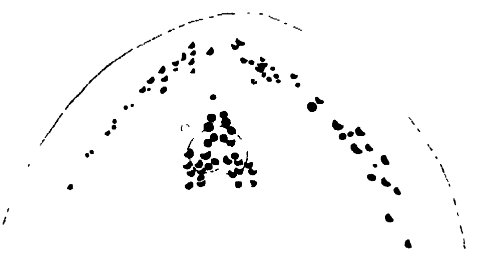

Fig. 19. *Prosthiostomum laetum*, arrangement of eyes. ×35.

The reproductive organs of this species are quite in accord with the type of the genus. The seminal vesicle is very large, provided with a thick muscular wall. The ejaculatory duct runs along the dorsal side, and after receiving the paired ducts of the accessory vesicles, opens at the tip of the penis. The accessory vesicle is large and spherical, surrounded with a thick muscular wall and containing a mass of eosinophilous secretion granules. The penial stylet is long. A large quantity of prostate gland secretion gathers around the cavity of the penis sheath. The arrangement of the female genital organs is much similar to that found in other species of this genus. The egg canal is directed anteriad.

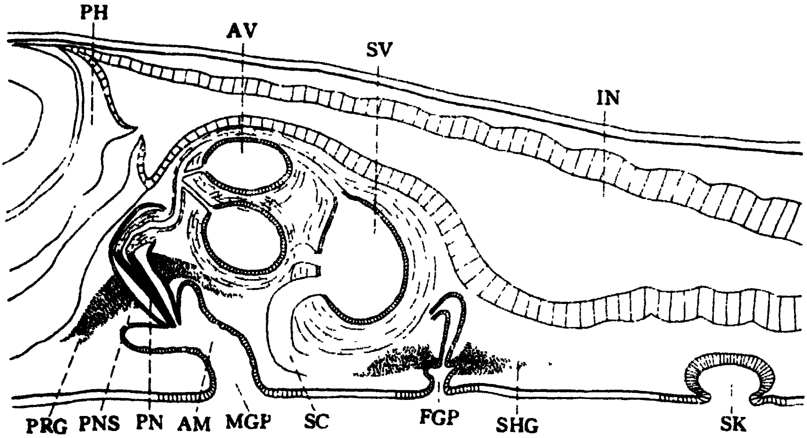

Fig. 20. *Prosthiostomum laetum*; sagittal section through genital organs. ×35.

The present worm differs distinctly from all other members of *Prosthiostomum* in the arrangement of the eyes as shown in Fig. 19, and in some minute points of the male genital organs.

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EXPLANATION OF PLATES

ABBREVIATIONS

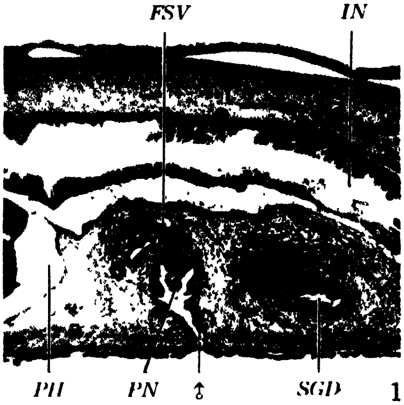
AF antrum femininum; AM antrum masculinum; AV accessory vesicle; CUD common uterine duct; ED ejaculatory duct; EG eosinophilous gland; FGP female genital pore; FSV false seminal vesicle; GVC genito-vaginal canal; GVP genito-vaginal pore; IN intestine; LGV Lang's glandular vesicle; MGP male genital pore; MW muscular wall; PGG post genital gland; PH pharynx; PN penis; PNS penis sheath; PRG prostate gland; PRV prostate vesicle; SC seminal canal; SGD shell gland duct; SGP shell gland pouch; SHG shell gland; SK sucker; SV seminal vesicle; UT uterus; VE vagina externa; VI vagina interna; ♂ male genital pore; ♀ female genital pore.

PLATE XXXVIII

1, 2. ***Bergendalia mirabilis*** sp. nov., sagittal section through genital organs. ×40
3. ***Cryptophallus sondaicus*** Bock, dorsal (left) and ventral (right) views. ×1
4. Ditto, sagittal section through genital organs. ×15.
5, 6. ***Hoploplana cupida*** sp. nov., sagittal section through genital organs. ×40.
7. ***Pseudostylochus edurus*** sp. nov., sagittal section through genital organs. ×40

PLATE XXXIX

1. ***Pseudoceros exoptatus*** sp. nov. ×1
2. Ditto, sagittal section through genital organs. ×26.
3. ***Prosthiostomum vulgaris*** sp. nov., anterior end of body. ×15
4. Ditto, sagittal section through genital organs. ×40
5. ***Prosthiostomum laetum*** sp. nov., anterior end of body. ×15.
6. Ditto, sagittal section through genital organs. ×73
7. ***Prosthiostomum auratum*** Kato, anterior end of body. ×15
8. ***Pseudostylochus maculatus*** sp. nov., sagittal section through genital organs. ×26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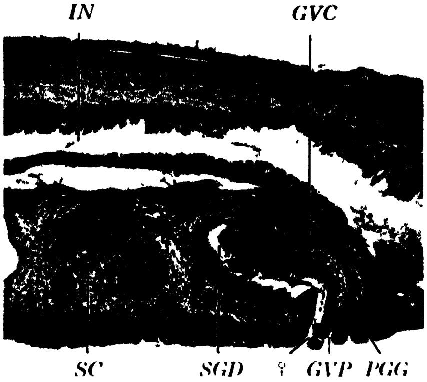
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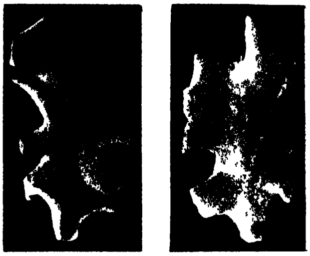

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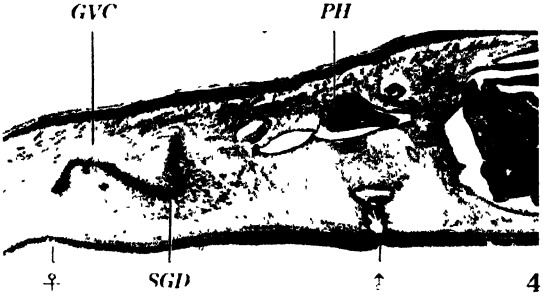
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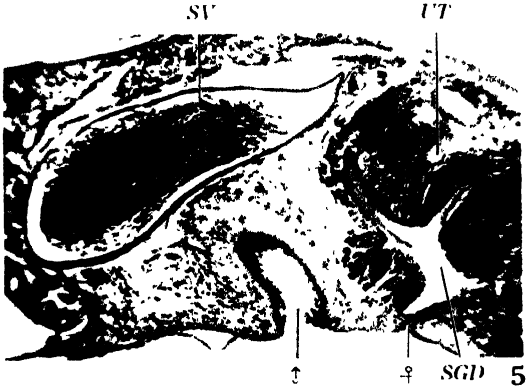
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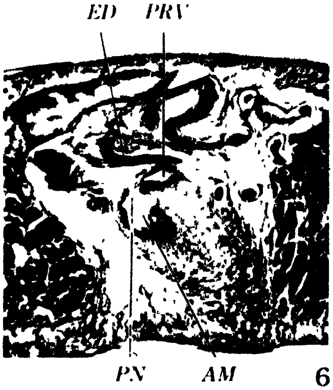
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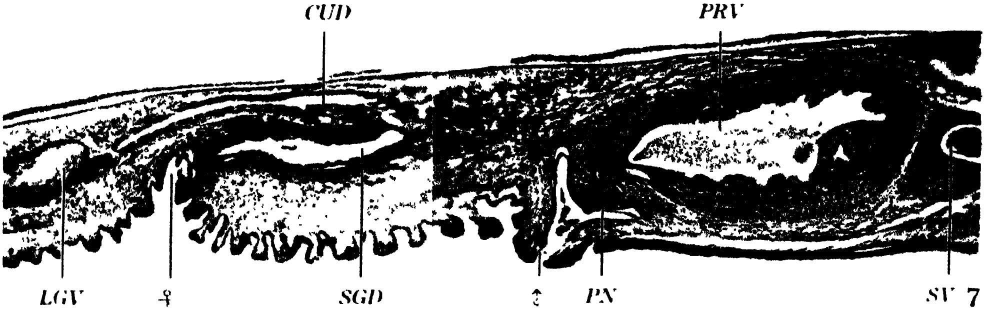
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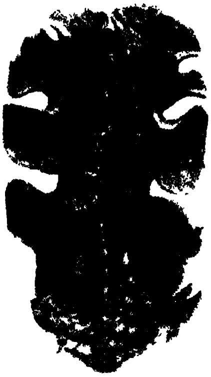

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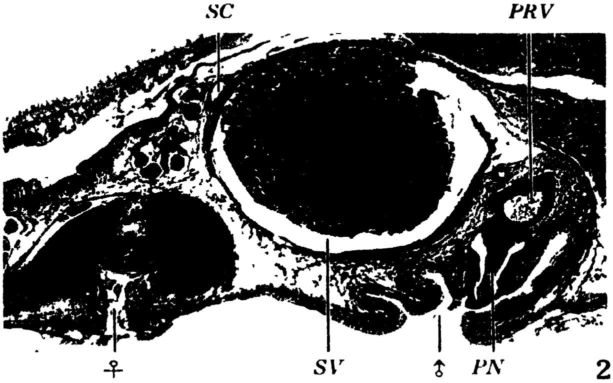

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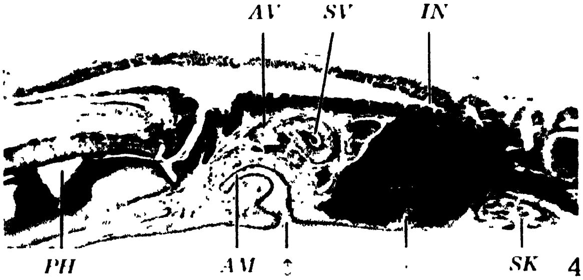

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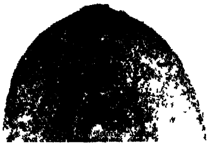

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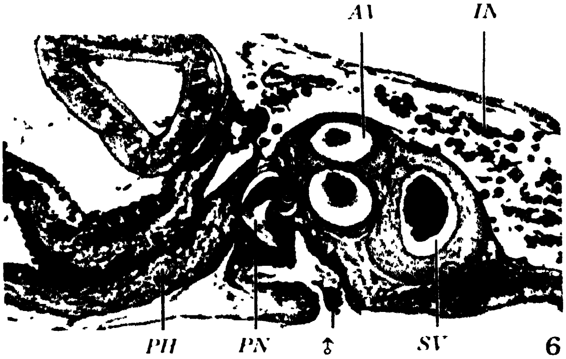

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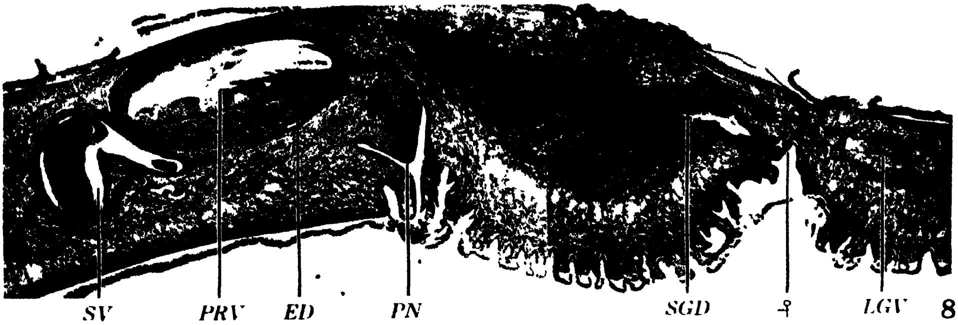

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27. Notes on Pelagonemertes moseleyi Bürger

By Kojiro KATO and Otohiko TANAKA
Mitsui Institute of Marine Biology, Susaki near Simoda, Sizuoka-ken

(With 2 Text-figures and Plate XI.)

Shortly after the first discovery of a pelagic nemertean, *Pelagonemertes rollestoni*, from far south of Australia, another specimen of *Pelagonemertes* was obtained by the Challenger on June 5, 1875, from a depth of 755–420 fathoms at about halfway between Oosima and Cape Sagami, and Moseley (1875 b) supposed it to be a young form of *P. rollestoni*. Bürger (1895), however, based on the differences of the shape of body and the number of intestinal branches, separated the Japanese form from the Australian one giving the former the name *Pelagonemertes moseleyi*. By the extensive surveys of the Albatross, the Valdivia and the Deutsche Südpolar expedition, a certain number of specimens of *rollestoni* as well as other two new species, *joubini* and *brinkmanni* (Coe, 1926), were collected from various seas of the world, while, so far as we are aware, no nemertean referable to *P. moseleyi* has been recorded since.

In the middle of November, 1937, one of the writers, Otohiko Tanaka, obtained several specimens of pelagic nemertean along with a large number of deep-sea medusae, copepods, arrow-worms, etc., by the vertical net from about 1,000 meters to the surface, at a station 3 miles off Hasima in Sagami Bay.

After close examination, two of the nemertean specimens revealed to be referable to *P. moseleyi* mentioned above. Though the Challenger's example was carefully studied while living, it was destroyed in an attempt of preservation, and the minute internal organizations of this worm have remained unknown. Here follows the emended description of the species, basing on our studies of the newly obtained material. One of the specimens was examined in serial sections.

The body is thick and broad, and the posterior end distinctly narrows, terminating in a more broadened caudal fin as in *P. brinkmanni*. The lateral margins are slightly undulating, but provided with no such distinct indentations as mentioned by Moseley. They are very thin near the posterior end of the body, looking like feeble horizontal fins as observed in *Nectonemertes*.

The Challenger's specimen measures 13 mm long, 11 mm broad and 1 mm in extreme thickness. One of the present specimens measures after preservation 13 mm in length and 9 mm across the broadest part of the body, and the other specimen 17 mm by 8.5 mm. Both specimens are about 5 mm in thickness in the middle of the forebody.

The body is almost hyaline, except for the alimentary canal which is full of glanulae and bright orange in color. This coloration persists in formalin for a fairly long time. The proboscis, ovaries, brain, and nerve-cords are opaque, and clearly seen through the translucent body-tissues.

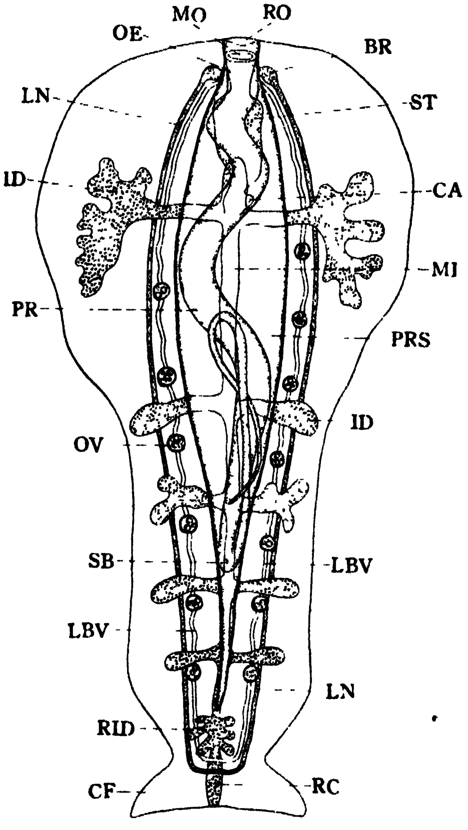

Fig. 1. Schematic representation of *Pelagonemertes moseleyi*. ×6.
BR brain; CA caeca; CF caudal fin; ID intestinal diverticulum; LBV lateral blood vessel; LN lateral nerve; MI main intestine; MO mouth; OE oesophagus; OV ovary; PR proboscis; PRS proboscis-sheath; RC rectum; RID rudimentary intestinal diverticulum; RO rhynchodeal opening; SB sickle-shaped basis; ST stomach.

The epidermis consists of ciliated columnar cells and glandular cells of two kinds, those filled with an eosinophilous granular secretion and those with a clear mucous secretion. The former glandular cells are especially abundant in the ventral epidermis of the caudal fin. Special integumentary sense-organs, similar to those found in *Nectonemertes* and certain other genera, are irregularly distributed on the whole surface of the body. The organ, as is shown in Fig. 2, consists of a conical group of extremely slender cells, at the base of each cell lies an elonagted nucleus. Further minute study on this organ is hardly possible owing to the poor state of preservation. The dermal musculature of the body is slightly developed, composed of two layers of isolated muscle bundles. The outer is a single circular layer and the inner, longitudinal one which is very weak in the lateral parts of the body. The dorso-ventral muscle fibers are scarcely observable.

In the Challenger's specimen, the anterior, median end of the body is evidently bilobed, but in the present specimens, in which the proboscis is in its normal position, it is rather bluntly pointed, and here open ventrally the rhynchodeum and the mouth. The mouth, occurring immediately behind the rhynchodeal opening, leads into a short oesophagus to continue on to a large stomach, which passes by its narrow pyloric part into the dorsal wall of the intestine a short distance from its anterior end. A small portion of the intestine lies as a caecum just in front of the pylorus-opening. The main intestine runs along the median line on the ventral side of the proboscis-sheath to the hind extremity of the body. Its short terminal portion forms

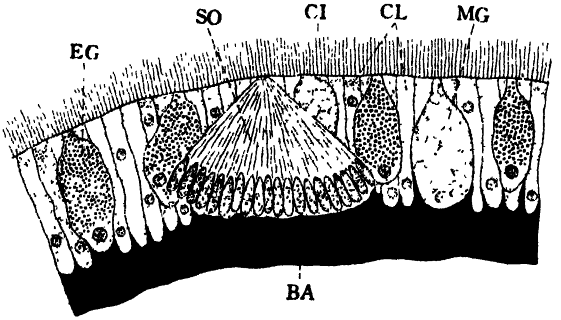

Fig. 2. Part of section through epidermis of *Pelagonemertes moseleyi.* ×600.
BA basement membrane; CI cilia; CL columnar cell; EG eosinophilous gland; MG mucous gland; SO sense-organ.

the rectum which opens to the exterior in the middle of the caudal fin. The main intestine bears 5 pairs of diverticula. In one specimen, all these pairs extend out symmetrically toward the lateral walls of the body, while, in another example, the posterior four pairs arrange alternately, viz., those on the right side are considerably anterior to the members of the corresponding pairs of the left side. Lying near the first fourth of the body, the most anterior pair of intestinal branches are much larger than any of the others and provided with a few caecal buds at their distal ends. The remaining pairs are of simple club-shape, except for the third one having a few buds. At the junction of the intestine and the rectum, there is a group of small lobes which are apparently rudimentary caeca. The internal epithelium of the intestine consists of two kinds of cells. The larger and more numerous cells have basal nuclei and their cytoplasm is crowded with vacuoles, and the others are rather small and filled with coarse, eosinophilous secretion granules. The bright orange color of the intestinal system is due to these granules.

The rhynchodeal opening leads into a short rhynchodeum, to its muscular wall is closely attached the proboscis. The eversible proboscis is thick and long, and greatly exceeds the body in length, lying in a convoluted state in the proboscis-sheath. The proboscis has the usual three communicating chambers: the anterior, the middle and the posterior one. The epithelial lining of these three portions are each quite in accord with those of *rollestoni* or *brinkmanni.* The small middle chamber contains, as usual, the armature which is represented by a sickle-shaped basis, the anterior free border of it bears about 7 stylets. Each stylet consists of a discoid base and a blunt, conical tooth. The proboscideal nerve consists of 11 large nerves alternating with an equal number of somewhat smaller ones, making a total of 22 nerves. The proboscis-sheath is very large and long, occupying nine-tenths the body length. It is almost spindle shape and the posterior part tapers to a narrow tube, which ends blindly in the midst of the surrounding parenchymatous tissue between the intestine and the dorsal body-wall. The muscular wall of the sheath is of far greater thickness than are the body-walls, consisting of two distinct layers: the outer, thick circular layer and the inner, thin longitudinal one.

The lateral blood vessels run parallel with the lateral nerve-cords and are united with three anastomoses; one of those is above the rectum, the second immediately above the rhynchodeum just anterior to the attachment of the proboscis, and the third beneath the proboscis-sheath just posterior to the ventral brain-commissure. Arising from the ventral anastomosis, a very short, dorsal, median vessel passes obliquely through the ventral wall of the proboscis-sheath to terminate blindly in rhynchocoel.

The brain is relatively small, while, the lateral nerves are very thick. They run about midway between the median line and the lateral borders of the body, and unite by a broad commissure above the rectum, a little more posteriorly than the anastomosis of the lateral blood vessels.

The two specimens available for study are both females as the Challenger's material. The ovaries arrange on the ventral side along the lateral blood vessels as if they were connected with the latters. The number of ovaries seems to be variable in this species. The Challenger's specimen has 8 ovaries on the right side, 7 on the left. In one of our specimens, there are 7 on the right, 8 on the left, and in the other, 7 on the left and 6 on the right. The ovary is spherical in shape, containing a few ova of varying developmental stages. It opens to the ventral side by a narrow oviduct which is lined with distinct columnar cells. According to Moseley, the oviduct makes its way to the dorsal side, but, his observation is erroneous as pointed out by Brinkmann.

As already mentioned, the present specimens differ from Moseley's original example in the possession of the caudal fin. However, judging from his description and figure, the Challenger's worm seems to be slightly injured and in a state of strong contraction. Therefore, it may be safely asserted that our material is identical with *P. moseleyi*. This species is easily distinguished from *rollestoni* and *joubini* by the presence of the caudal fin just mentioned, and from *brinkmanni* by the arrangement of the intestinal branches and the number of the proboscideal nerves.

The male individual of this species has never been captured.

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PLATE XL

Pelagonemertes moseleyi Bürger

A. Natural size.
B, C. Enlarged.
D. Transverse section at the level of the third pair of intestinal diverticula. ×40.
E. Transverse section through middle chamber of proboscis showing sickle-shaped basis. ×57
F. Part of section through epidermis showing two sense-organs. ×140.

ABBREVIATIONS

1. anterior chamber of proboscis; *2.* middle chamber of proboscis; *3.* posterior chamber of proboscis; *4.* sickle-shaped basis; *5.* rhynchocoel; *6.* main intestine; *7.* lateral diverticulum of intestine; *8.* ovary; *9.* oviduct; *10.* lateral blood vessel; *11.* lateral nerve; *12.* integumentary sense-organ.

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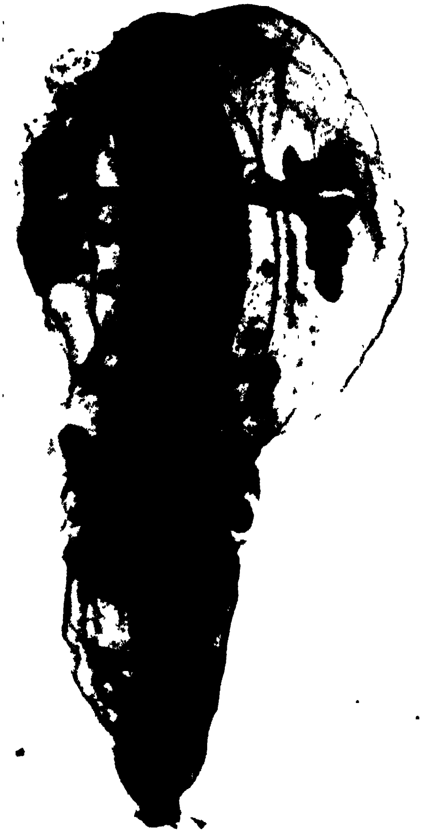

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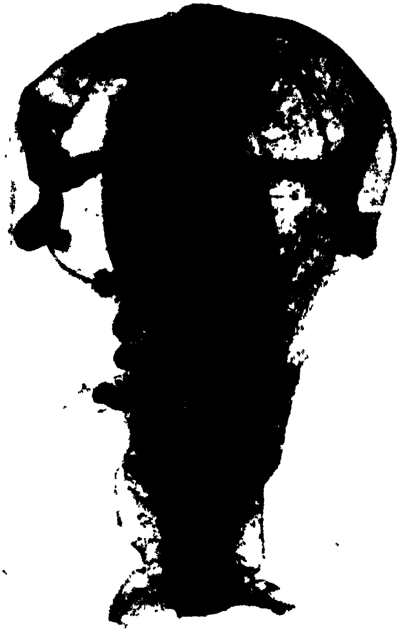

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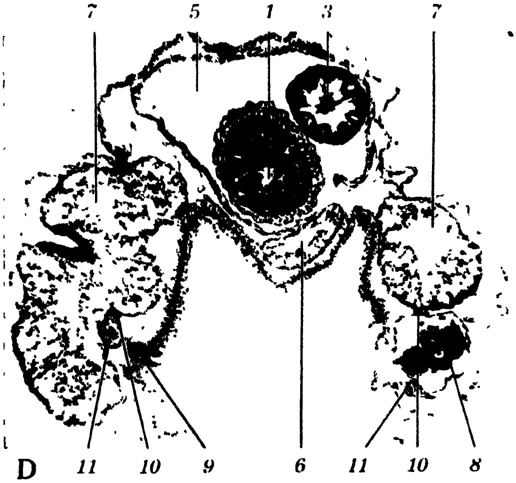

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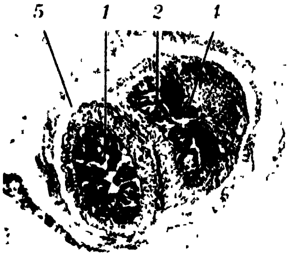

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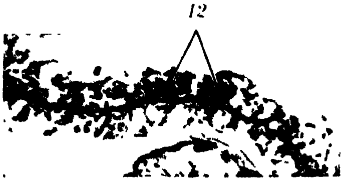

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28. Note on Calanus cristatus Kröyer

By Otohiko TANAKA

Mitsui Institute of Marine Biology, Susaki near Simoda, Izu

(With 2 Text-figures)

Since Kröyer had in 1848 first described *Calanus cristatus* by the specimen from Kamchatka, several authors had the opportunities to observe the same species collected in different parts of the world. But all the specimens they examined, so far as I know, were only immature females and not a single male nor adult female has been reported. This species of cold region is very abundant in the northern waters of Japan. The species is easily recognised by its large size and the crest on the forehead. In November 1937, vertical hauls were carried out with a stramin net of 1 metre diameter in the deep waters of Sagami Bay. The collected sample contained not only adult females but also males of the present species. Some of the females carried in the ovary eggs measuring about 0.3 mm in diameter. In the following I give a brief description and figures.

Female: Length 8.4–9.3 mm. Abdomen is contained 4.6-times in the length of the cephalothorax. Lengths of the abdominal segments and furca in 0.01 mm 71, 25, 13, 14, 32 (Fig. 1. a). Furca about 1.4-times as long as wide. Genital segment with a small protuberance on the middle of the genital orifice (Fig. 1, b, c). Forehead with a median crest.

Distal joints of the antennules were broken off in all specimens. Mouth appendages are of the normal *Calanus* type. Swimming feet with 3-jointed exopodite and endopodite. In the 5th feet (Fig. 1, f), inner margin of the 1st joint of the basipodite smooth and without marginal seta; the outer marginal spine on the 3rd joint divides the outer margin in the proportion 5 : 4; the inner margin has 4 setae; the 1st joint of the endopodite with a spine on the outer edge and this is rudimentary in the 2nd to 4th feet; the 3rd joint with 4 inner marginal setae.

Male: Length 7.4–8.6 mm. Male resembles female in general appearance except the low median crest (Fig. 2, a, b). Abdomen (Fig. 2, c) is contained about 3.5-times in the total length of the cephalothorax. Abdomen is 5-jointed; the lengths of the abdominal segments and furca in 0.01 mm are 27, 57, 32, 18, 20, 21.

Antennules 24-jointed, extend beyond the end of the abdomen by last 3 joints. Lengths of the joints measured along the posterior margin in 0.01 mm are as follows:

Joint:	1–2	3	4	5	6	7	8	9	10	11	12	13	14
Length:	54	39	25	29	27	27	22	22	32	36	41	45	48
Joint:	15	16	17	18	19	20	21	22	23	24	25		
Length:	48	50	50	50	52	43	39	36	30	25	18		

Mouth appendages well developed except the 1st maxillipede (Fig. 2, d).

1st to 4th swimming feet as in the female. 5th feet (Fig. 2, e) resemble those of *C. gracilis*. The 3rd joint of the exopodite of the right foot without

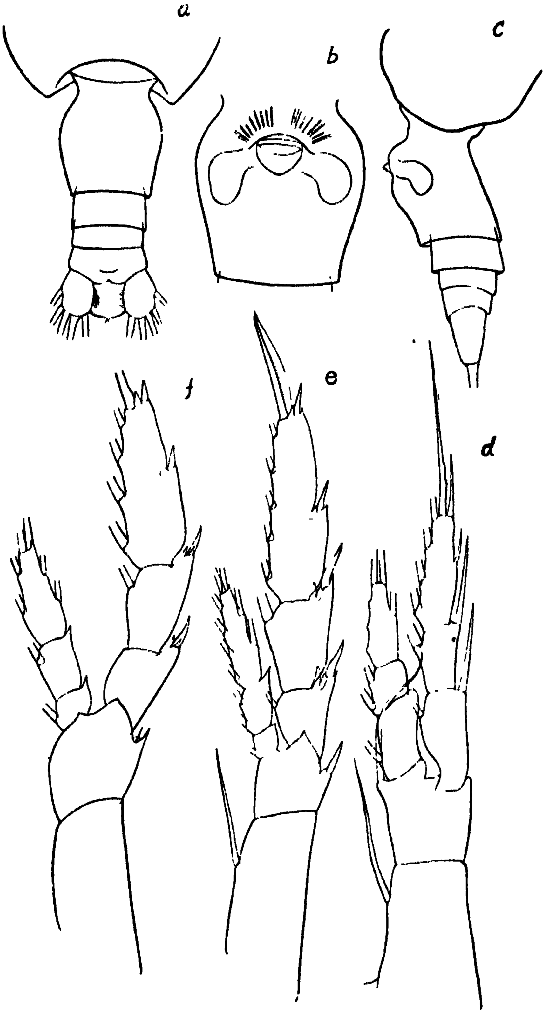

Fig. 1. *Calanus cristatus*. Female.
a, abdomen, dorsal view, ×18
b, genital segment, ventral view, ×30
c, abdomen, lateral view, ×18
d, 1st foot, ×43
e, 4th foot, ×30
f, 5th foot, ×43

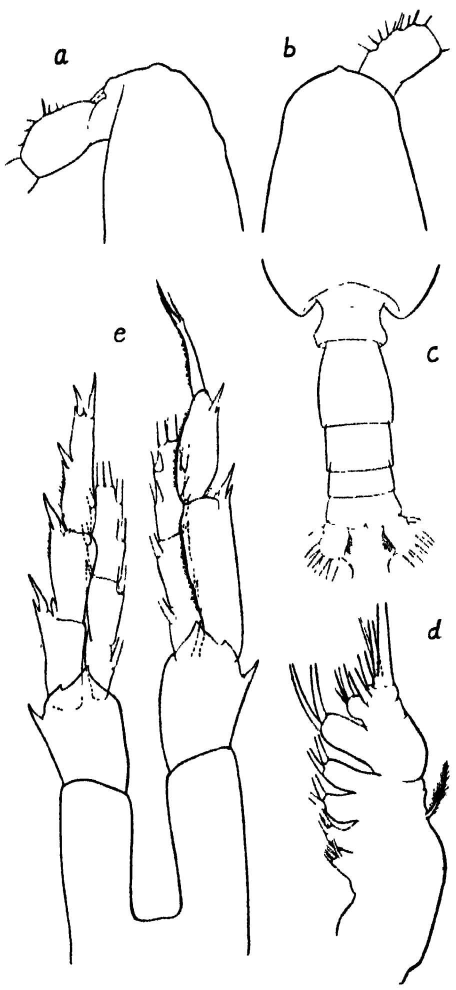

Fig. 2. *Calanus cristatus*. Male.
a, head, lateral view, ×13
b, head, dorsal view, ×13
c, abdomen, dorsal view, ×18
d, 1st maxillipede, ×60
e, 5th feet, ×43

inner marginal seta. The 1st and 2nd joint of the exopodite of the left foot are densely fringed with rather stiff hairs along the inner margin; the terminal spine on the 3rd joint is furnished with spinules.

Immature specimens are all female and have 2-jointed exopodite and endopodite in the 5th feet. They measure 7.8–8.7 mm in total length.

Occurrence: 14 adult females, 6 males and 24 immature females in the vertical hauls from 1,000 m to the surface.

Distribution: The species has been recorded from the Behring Sea, Kamchatka and Japan Sea. It is also very common in the northern waters of Japan in the surface layer. I had previously collected a great quantity of immature specimen from the Aleutian Islands. Breemen reported the occurrence of this species in the deep waters of 560–1500 fathoms in the Atlantic (52°N).

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29. Studies on the Helminth Fauna of Japan

Part 23. Two New Species of Amphibian Nematodes

By Satyû YAMAGUTI

Laboratory of Parasitology, Kyoto Imperial University

(With 2 Text-figures and Plate XLI)

One of the species here described is the commonest frog nematode in Japan but the other one representing a new family is very rare, inasmuch as it has been found only once during the long course of my research.

Gyrinicola japonica n. g., n. sp.

Pl. XLI, Figs. 1–4.

About twenty specimens of this worm were found in the feces discharged by a tadpole of *Rana rugosa* Schlegel from near Kyoto on September 30, 1936. They were examined in life, then fixed in alcohol and mounted in lactophenol.

FEMALE. Body 2.0–3.7 mm long by 0.15–0.3 mm broad, cylindrical except for extremities. The esophageal region tapers gradually toward the head, which in turn narrows more rapidly and is truncated at the end. Tail 0.2–0.31 mm long, conical, terminating in a slender process 0.13–0.16 mm long. Cuticle smooth throughout, though frequently folded transversely at the neck region in fixed examples. Lateral flanges and caudal alae absent. Nerve ring 0.1–0.165 mm from head end. No cervical papillae. Excretory pore 0.27–0.46 mm behind esophageal bulb.

Mouth with six small lips, two lateral and four submedian. Each lateral lip is provided with a very prominent horn-like amphid and each submedian one with a hemispherical papilla. Mouth cavity relatively wide, not forming chitinous capsule, leading directly into esophagus. Neither vestibule nor pharynx. Esophagus 0.3–0.46 mm long, divided by marked constriction into anterior cylindrical portion 38–48 μ broad and posterior subglobular bulb 90–126 μ broad. The anterior portion has a triradiate lumen and the posterior a valvular apparatus consisting of three ridges projecting into the lumen. The cuticular lining of the esophagus is continued on to the very beginning of the intestine. Esophageal gland well developed, especially in the bulb. Intestine dark brown in life, with bulbous swelling at its anterior end, almost uniformly wide elsewhere, surrounded by three (one ventral and two lateral) large oval cells at its junction with rectum.

The single tubular ovary, originating at some distance in front of the anus with its proximal end turning forward, runs up to the level of the excretory pore, where it first turns backward and then forward in an S-shaped curve and passes into the uterus forming somewhat complex loops at the anterior part of the intestine. The descending uterus reaches to a point some distance in front of the anus, then turning back on itself proceeds anteriad and joins a fusiform organ to form the muscular vagina 0.15–0.3 mm long. The fusiform organ, which I propose to call "uterine reservoir", is lined like the uterus proper with a layer of flat epithelia and contains several free males and eggs in various stages of development, and lies at about the middle of the body, with the rod-shaped anterior end reaching to near the excretory pore and the posterior turning forward to open into the vagina. It may be considered the vestige of a uterus, now functioning as reservoir of males. Vulva postequatorial, dividing body in ratio of 1.1–1.33 : 1. Eggs double-shelled, each containing two to four large blastomeres; outer shell elliptical in side view, trilobate in transverse section, very finely and densely dotted on inner surface, 87—96 × 48—54 μ in life; inner shell elliptical, closely applied to ovum, 51—54 × 31—33 μ in life. Some eggs in the uterine reservoir mentioned above are elongate, 120–126 μ long by 30–36 μ broad and contain a morulated ovum.

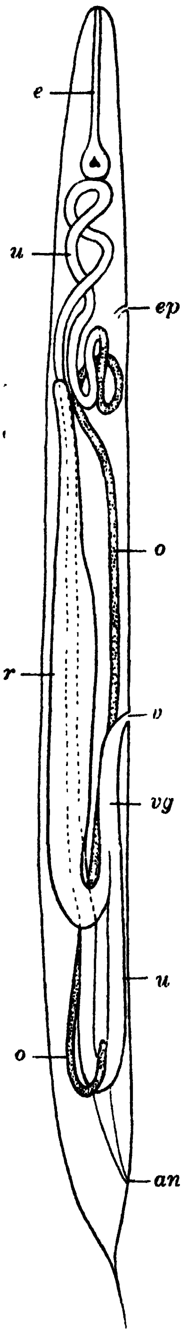

Fig 1. *Gyrinicola japonica.* Lateral view of female, showing genitalia diagrammatically.

MALE. Body cylindrical for the most part, 0.8–0.87 mm long by 50–60 μ broad, tapering anteriorly at esophageal region. Head blunt-pointed. Tail acute, 80 μ long, with a pair of papillae on ventral side about 50 μ from its tip. Nerve ring 60–63 μ from head end. Excretory pore about 0.1 mm behind esophageal bulb. Esophagus 0.114–0.12 mm long; bulb 28–32 μ in diameter. Testis turning backward 50 μ behind esophageal bulb. Spicules unequal, simple, pointed; the posterior, only slightly curved near proximal end, 42–44 μ long; the anterior curved at about its middle, a little longer than the posterior. Gubernaculum absent. Cloaca opening on a prominent conical protuberance provided with a fairly conspicuous swelling on posterior side. A pair of small papillae on anterior side of cloacal cone near its end, and another immediately behind cloacal aperture In younger males no spicules have been observed.

This oxyuroid nematode is characterized by the male being enclosed in one of the uteri of the female, which has been transformed into a fusiform sac functioning as reservoir of males and eggs. So far as the female genitalia are concerned, the present species occupies a position intermediate between the Atractidae possessing a single ovary and the other families of the Oxyuroidea possessing two ovaries. Therefore it represents not only a new genus but also a new family, for which the name Gyrinicolidae is proposed, with the following diagnosis.

Gyrinicolidae n. fam.

FAMILY DIAGNOSIS. Oxyuroidea Railliet, 1916. Females with one ovary and two uteri, one of which is transformed into a sac enclosing males.

Gyrinicola n. g.

GENERIC DIAGNOSIS. Gyrinicolidae n. fam. Body cylindrical, without lateral flanges. Mouth with six lips, of which the lateral has a very prominent amphid and the others have one papilla each; vestibule and pharynx absent; esophagus divided by marked constriction into anterior cylindrical portion and posterior bulb containing valvular apparatus. Excretory pore some distance behind esophageal bulb. Male: tail acute; caudal alae absent; cloacal region projecting prominently, with few anal papillae; spicules unequal; gubernaculum absent. Female: tail conical, prolonged into a slender process; vulva near middle of body. Viviparous. Parasites of tadpoles.

Genotype. *Gyrinicola japonica.*

Cosmocerca japonica n. sp.

Pl. XLI, Figs. 5-7.

This worm is very common in the large intestine of *Rana nigromaculata* Hallowell and *R. rugosa* Schlegel from near Kyoto. It was also found in *R. japonica* Günther from Mount Hiei and *Hyla arborea japonica* Günther from Suwa, Nagano Prefecture. The following note is based on a single male from *R. nigromaculata* and numerous females from the same host species as well as from the other species mentioned above.

MALE. Body 1.8 mm long by 0.15 mm broad, with its posterior portion curved ventrally in form of a hook, provided with narrow lateral flanges and six longitudinal rows of minute papillae, which are more closely set in the pre- and postanal regions than elsewhere. Head 22 μ in diameter. Tail rapidly tapering posteriorly, 0.12 mm long on ventral margin, tipped with acicular spine 13 μ long. Pharynx short cylindrical, 12 μ in diameter, projecting into mouth in three conical processes. Esophagus 0.3 mm long; anterior cylindrical portion 0.21 mm long by 24 μ broad; posterior glandular portion flask-shaped, 60 μ broad in diameter, containing valvular apparatus. Intestine wider at its anterior half. Rectum vesicular. Pre-anal cuticle thickened, ornamented ventrally with five pairs of plectanes. Each plectane consists of two chitinous rods with very fine transverse ridges on the surface and jointed with each other in the shape of a λ, with the conical pulp in the interspace. In ventral view the posterior end of the anterior rod projecting over the surface of the cuticle appears to be surrounded by a semicircle of six very small chitinous tubercles. There is a single, well-chitinized, two-segmented spicule consisting of a slightly curved pointed shaft 70 μ long and a broader root 34 μ long. Immediately ventrolateral to the spicule lies a pair of homogeneous, strongly refractive laminae, each of which is approximately ellipsoidal in side view and measures 84 μ long by 45 μ wide. At the level of the cloaca there are five pairs of papillae, three of which are in line with those of the body mentioned above and the other two immediately lateral to the cloacal aperture. Immediately in front of this aperture is a large median papilla and a little behind it are two relatively large ones, one on either side of the median line. The other tail papillae appear to be in the same longitudinal rows of the body papillae.

Testis 0.075 mm broad, extending from second pair of plectanes to a point 0.275 mm behind esophageal bulb, where it turns backward. Excretory pore on a level with esophageal bulb.

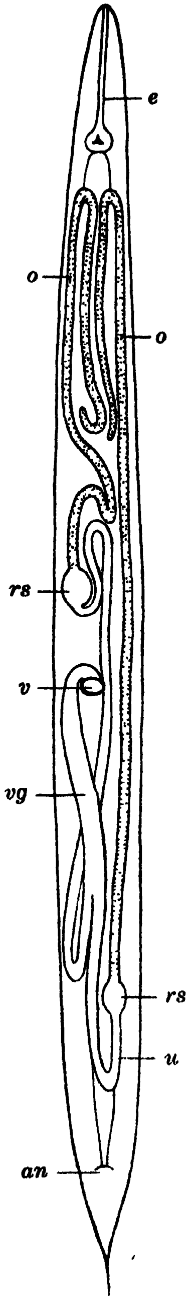

Fig. 2. *Cosmocerca japonica*. Ventral view of female, showing genitalia diagrammatically.

FEMALE. Body 2.9–4.9 mm long by 0.17–0.35 mm broad at about middle, whence it tapers gradually toward the head but rapidly at the tail which is 0.3–0.49 mm long and terminates in a simple slender process 0.14–0.18 mm long and provided with a pair of minute lateral spines at a point 90–130 μ from the tip. Lateral flanges up to about 20 μ broad, extending from 0.07–0.1 mm behind head end to base of tail process. There are four longitudinal rows of minute papillae extending for the same length of the body as the lateral flanges. Nerve ring 0.1–0.17 mm from anterior extremity. Excretory pore transversely elongated, up to 45 μ wide, level with esophageal bulb or a little behind it. It may be in front of the bulb when the head end is retracted. Mouth with three lips; each subventral lip bears one papilla but the dorsal two. Pharynx 15–21 × 21–45 μ, projecting into mouth cavity in three pyramidal processes. Esophagus 0.36–0.5 mm long; anterior cylindrical portion 30–51 μ broad, posterior glandular bulb 87–126 μ in diameter, containing valvular apparatus. Intestine wider anteriorly, dark brown throughout, surrounded at its posterior end by three large ovoid cells containing fine granules and projecting into body cavity. Rectum 90–

120 μ long, lined with thick cuticle.

The two ovaries arising at a pre-equatorial level proceed forward and turn back on themselves 0.11–0.45 mm behind the esophageal bulb and pass each into the oval receptaculum seminis, one in front of the vulva and the other further posteriorly. The uterus arising from the anterior receptaculum seminis runs forward for a short distance and then turning backward reaches to near the posterior receptaculum seminis, where it turns forward to join its fellow descending from the posterior receptaculum seminis and bending forward at varying levels according to individuals. The vagina runs forward and turns back on itself before opening to the outside. Vulva usually only a little behind middle of body. Eggs ellipsoidal, thin-shelled, containing active embryo.

Larva. As killed in 70% alcohol and mounted in lactophenol, the hatched larva is 0.42–0.48 mm long by 24–27 μ broad, with pointed tail 6–75 μ long. Nerve ring 27–30 μ from head end. Excretory pore in front of esophageal bulb, 90–95 μ from head end. Pharynx short cylindrical, 9 × 6 μ. Esophagus 102–114 μ long, with oval bulb 13–15 μ in diameter.

This species differs from the most closely related *Cosmocerca parva* Travassos, 1925, chiefly in body size as well as in the structure of the spicule. That the tail of the male is provided at the tip with an acicular spine is also worth noting.

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Explanation of Plate XLI

Figs. 1–4. *Gyrinicola japonica*
Fig. 1. Female, lateral view, ×25.
Fig. 2. Male, lateral view, ×75.
Fig. 3. Head of female, lateral view, ×315.
Fig. 4. Female terminal genitalia, lateral view, ×25.

Figs. 5–7. *Cosmocerca japonica*
Fig. 5. Female, lateral view, ×25.
Fig. 6. Male, lateral view, ×35.
Fig. 7. Anal region of male, lateral view, ×300.

Abbreviations used in Figures

a	amphid
an	anus
e	esophagus
eb	esophageal bulb
ep	excretory pore
i	intestine
o	ovary
p	papilla
pl	plectane
r	uterine reservoir
rs	receptaculum seminis
sp	spicule
t	testis
u	uterus
v	vulva
vg	vagina

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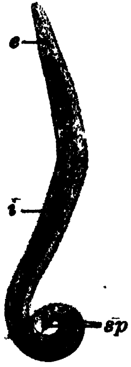

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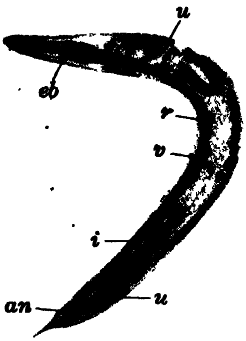

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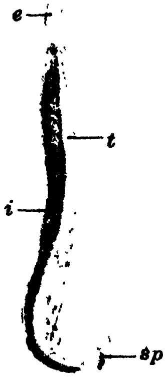

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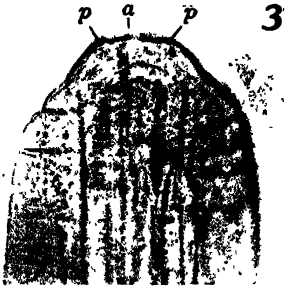

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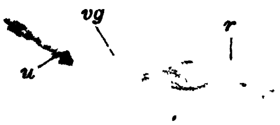

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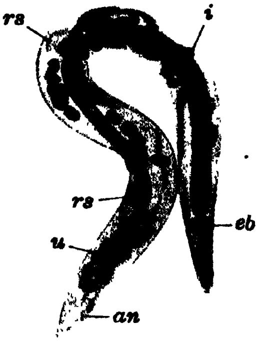

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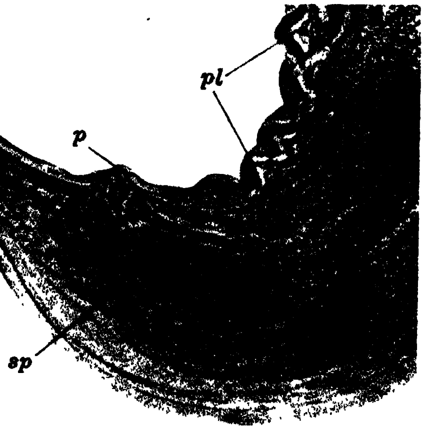

30. On the Life History of Loxogenes liberum Seno, 1907, with Special Reference to the Cercaria

By Satyû YAMAGUTI

Laboratory of Parasitology, Kyoto Imperial University.

(With 3 Text-figures)

Okabe has recently determined experimentally that the cercaria of *Loxogenes liberum* Seno develops in *Bulimus kiushuensis* Hirase and encysts in *Sympetrum darwinianum* Selys and *Orthetrum albistylum* Selys. I have also succeeded in obtaining encysted metacercariae of this worm from *Orthetrum albistylum* Selys and *Crocothemis servilia* Drury by an experimental infection with a stylet cercaria of the "Virgula" group of Sewell which developed in small plump sporocysts in *Bulimus striatulus japonicus** from a village near Okayama where the frog trematode occurs not uncommonly.

As measured in life under a cover slip the oval body of the cercaria, finely spined all over, varied from 0.084 to 0.17 mm in length and from 0.05 to 0.084 mm in breadth according to states of contraction; when extended it may be up to 0.224 mm by 0.098 mm broad. The tail measures in the same condition 0.05–0.112 mm long by 14–17 μ broad. There are thirteen hairs on each side of the body, though not mentioned by Okabe. The oral sucker containing the virgula organ at the base is 25–34 μ long by 25–39 μ broad, and the postequatorial acetabulum 17–22 μ in diameter. The stylet is 17–19 μ long by 3–4 μ broad. There are constantly four pairs of pyriform penetration glands, one directly behind another. The secretion granules, unstained with neutral red, are coarser in the anterior two pairs than in the posterior two, and the gland ducts of the anterior group are made up on each side into a bundle like those of the posterior group and lie medial to the latter, with their openings near the stylet, ventral to those of the posterior glands. The collecting vessel arising from the tapering anterior end of each limb of the V-shaped excretory vesicle divides into three tubules, each of which terminates in two flame cells. The flame cells are so difficult to detect that Okabe found only one pair, but a continued observation has revealed the presence of three pairs on each side, two in the forebody and one in the hindbody, making a total of 12.

The numerous, fine, strongly refractive granules are seen scattered in the parenchyma of the living worms as pointed out by Okabe, but disappear after fixation in acetic sublimate.

The measurements made on three mounted specimens fixed in acetic sublimate under a cover glass are as follows: Body 90–99 × 63–66 μ; tail 33 μ long; oral sucker 24–27 μ in diameter; acetabulum 15 μ in diameter. As compared with the measurements given by Okabe the cercaria from *Bulimus striatulus japonicus* is smaller, when alive or fixed, in the size of the body, suckers, etc.

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*More recently Okabe has found that this species also serves as the first intermediate host for *Loxogenes liberum*.

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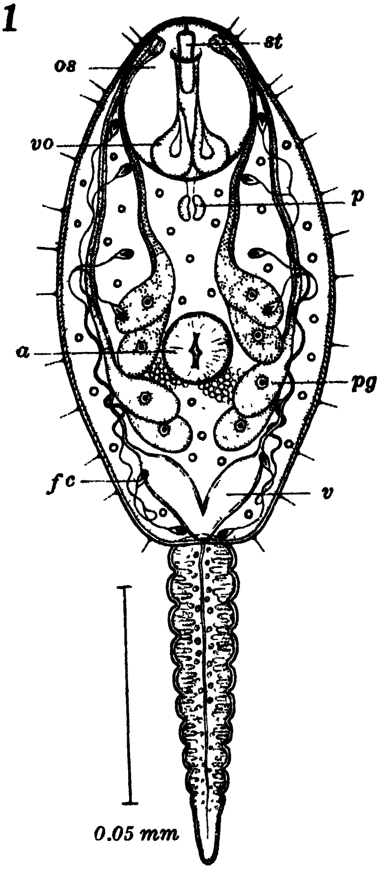

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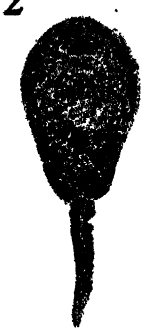

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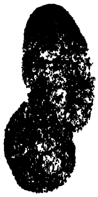

Fig. 1. Cercaria of *Loxogenes liberum* Seno; ventral view. *a* accetabulum, *fc* flame cell, *os* oral sucker, *p* pharynx, *pg* penetration gland, *st* stylet, *vo* virgula organ, *v* excretory vesicle.
Fig. 2. Free swimming cercaria; ventral view. ×200.
Fig. 3. Full-grown sporocyst. ×50.

In the free tailless cercaria, which penetrated into the body of a nymph of *Orthetrum albistylum* two days before, the virgula organ as well as the penetration glands of the posterior group is no more recognizable, whereas the stylet and the glands of the anterior group persist even in the earlier stage of encystment. This fact leads us necessarily to the assumption that the virgula organ plays some important rôle during the act of penetration into the body of the dragon-fly nymph and that its disappearance is correlated with the exhaustion of the posterior penetration glands.

The cyst of the metacercaria obtained from *Orthetrum albistylum* four days after infection is delicate, globular to oval, measuring 75–80 μ by 60–75 μ, and contains numerous granules. About a month later it becomes much larger and double-walled, the outer cyst measuring 0.36–0.4 × 0.35–0.36 mm and the inner 0.32–0.38 × 0.31–0.33 mm. At this stage of development the metacercaria shows distinct anlagen of the testes and ovary. When full maturity is reached, the cyst is inclosed in a connective tissue layer of the host origin, which becomes gradually thicker and appears dark brown with increasing pigmentation, while the cyst proper and the contained metacercaria become smaller accordingly. In spontaneously infected dragon-fly nymphs from Okayama degenerating cysts are found very often. The metacercaria agrees completely with that which was experimentally raised to adult in *Rana nigromaculata* in 1936.

Experiment. On June 12 several infected examples of *Bulimus striatulus japonicus* were placed in the same tank in which a number of nymphs of *Orthetrum albistylum* Selys, *Crocothemis serivilia* Drury and *Gomphus unifasciatus* Oguma from Simogamo had been kept. On July 19 numerous cysts were recovered from *Orthetrum albistylum* and *Crocothemis servilia* but none from *Gomphus unifasciatus*. Some twenty cysts were fed to each of three frogs, *Rana nigromaculata*, and nine days later an immature adult was found in one frog. The other two frogs proved negative for the parasite when killed on July 30. This unsatisfactory result is probably due to immaturity of the metacercariae used.

In conclusion it is to be noted that the nymph of *Gomphus melanops* Selys serves as a second intermediate host in the above mentioned locality near Okayama, though subordinate to *Orthetrum albistylum* Selys.

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31. On Crustacean Blood Coagulation[1]

By Haruo NUMANOI
Urawa Kôtôgakkô, Urawa

(With 13 Text-figures and 12 Tables)

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I

Introduction

While many papers published on the crustacean blood coagulation have been limited to the cytological observation, Loeb ('03) on *Astacus* and other crustaceans, Halliburton ('85) on the Decapod crustacea and Alsberg and Clark ('08) on *Limulus* studied physiologically the mechanism of the blood coagulation, though the results were not enough theorized. Because the crustacean blood contains no true thigmocyte, erythrocyte and the property of the plasma differs much from that of vertebrates, simple deduction from the blood coagulation of the latter may be very perilous.

The basal mechanism of the blood coagulation of several crustaceans apart from that of vertebrates will be described in the following chapters.

I here express my cordial thanks to Professor N. Yatsu, Professor I. Amemiya, Dr. T. Kamada and the late Mr. S. Kikuzawa for their kind guidance and encouragement. Thanks are also due to the Mitsui Institute of Marine Biology where facilities for the investigation were afforded during the summers of 1936 and 1937. The study was partly aided by the grant of the Ministry of Education.

II

Effect of Temperature on the Coagulation of the Blood of *Ligia exotica*

Method

Fully grown males, 35–45 mm in length with no sign of ecdysis were used in all of the experiments. When the basal parts of both antennae were cut, the blood flowed out in drops, 4 drops being 0.10–0.12 cc.

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[1] Contribution partly from the Mitsui Institute of Marine Biology.

The temperature of the blood was controlled by immersion in the ordinary water bath for the higher temperature range and by placing in the newly devised apparatus (in which the temperature was constant for short intervals only) for the low temperature.

Main part of the apparatus consisted of three-hold aquaria. In order to insulate the effect of outside temperature, cotton was propped into the space between the outer and the middle. Ice and water were introduced between the middle and the inner as a cooling mixture. Tap water was flowed in and out to keep the temperature of the inner aquarium constant. As the observation could be finished within ten minutes, this apparatus served well for the purpose. Dark violet coloured, thick walled hollow slide-glass was kept horizontally by the glass knife edge in the inner aquarium. The mode of the blood coagulation could be observed with ease from outside. The temperature of the subterranean laboratory was about 25°C throughout the experiment.

Mode of blood coagulation

The coagulation of the blood poured out on the slide-glass begins from the marginal contact region toward the center gradually over the bottom surface (Fig. 1), then the thin film of the coagulant is formed on the surface of the blood, and the blood between these two layers remains liquid to the last. The process of the coagulation might be divided into four successive stages, i. e. marginal coagulation, bottom coagulation, surface film formation and perfect coagulation, when the blood changes into the gelatinous clot.

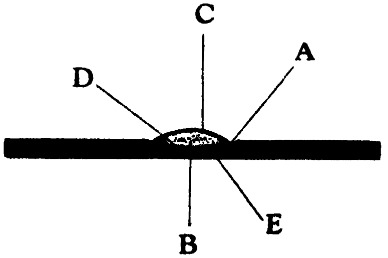

Fig. 1. Diagranatic illustration of mode of blood coagulation.
A, marginal coagulation
B, bottom coagulation
C, surface film formation
D, perfect coagulation
E, slide-glass

The stage of surface film formation is observable easily from outside. After this time, the end point of the perfect coagulation can be determined by the frequent inversion of the inner aquarium.

Limit of temperature for coagulation

Loeb ('03) described that heating of the crustacean serum to 46°-50°C for 30 minutes, prevented the coagulation. Moreover it can be prevented by the previous heating of the animal; the blood of *Limuli* heated for 30–40 minutes up to 50°-54°C did not coagulate after having been shed. Lobster and *Lebinia*, heated to 45°–48°C, for 30 minutes lost their coagulability. Halliburton ('85) also described that if the blood of crayfish be kept at the temperature of melting ice, it remained liquid. And after an hour on removal from the cold it coagulated as usual, only more slowly, the jelly not being firm for 20 minutes.

The coagulation of the blood of *Ligia exotica* is prevented at 50°C for 30 minutes, though it coagulates at 45°C within a minute. The high limit of the temperature for coagulation is 46°C. While the blood remains liquid below

4°C for 10 minutes, it freezes near −2°C. When the frozen blood is removed to the optimum temperature, it restores its coagulability again. The effect of the superheating is, on the other hand, irreversible.

Adaptation temperature and temperature coagulation curve

The seasonal effect on the blood coagulation of *Ligia exotica* is remarkable, the time of the coagulation differing markedly in summer and in winter at the same temperature, so the effect of adaptation temperature for the coagulation is examined.

Animals were adapted in three different temperatures 10°, 20° and 30°C respectively prior to the experiment for a day or two. If the time of blood coagulation of these animals is plotted against temperatures between the limit for coagulation, three caternary curves are drawn as are shown in Fig. 2.

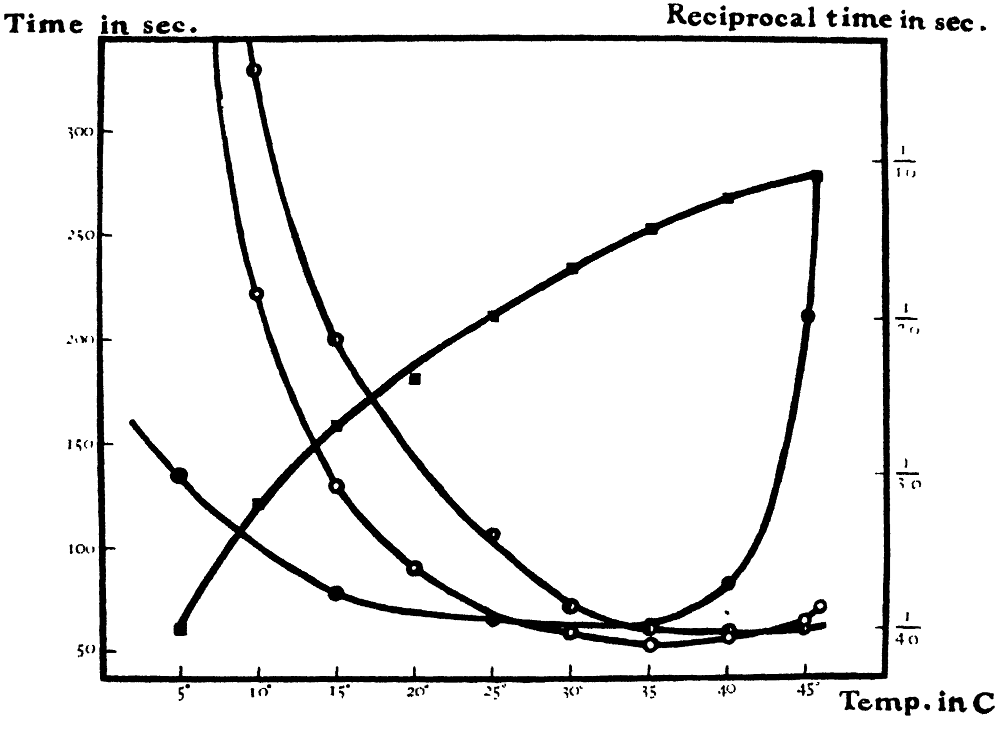

Fig. 2. Temperature coagulation curves at different adaptation temperatures and temperature viscosity curve of the blood of *Ligia exotica*. ◐ coagulation curve at 10°; ○ at 20°; ● at 30°C adaptation respectively. ■ viscosity curve.

Each curve has the minimum time of coagulation near 35°C, which is vague in those previously kept at 10°C, while very clear in 30°C adapted animals. Whatever the adaptation temperature may be, the lower the temperature the more decreased the coagulability below the optimum temperature, while the relation is reversed in the higher temperature. Moreover, the temperature coagulation curves show that the coagulation time of the cold adapted animal is longer than the warm adapted one below 35°C, while in the higher temperature range this relation is reversed. The time of the blood coagulation at different temperatures for adaptation is shown in Table 1.

Table 1

Time of blood coagulation at different adaptation temperatures

Temperature	Adaptation temperatures					
	10°C		20°C		30°C	
	Observed in sec.	Calculated in sec.	Observed in sec.	Calculated in sec.	Observed in sec.	Calculated in sec.
5°	1200	1050	955	680	134	130
10°	330	380	223	250		98.0
15°	200	210	130	135	77.8	81.0
20°		130	90.0	93.0		72.5
25°	108	98.0		71.0	65.0	66.0
30°	71.7	74.0	60.0	55.0		61.5
35°	60.0	60.0	52.5	40.0	60.0	59.0
40°	57.1		57.5		81.7	
45°	60.0		63.8		210	
46°	—		71.3		—	

Effect of water contents

The habitat of *Ligia* in winter is remote from the tide marks and it lives in the clefts and under stones of sunny places. So the coagulability of the blood of the winter animal is stronger than that of summer at the same temperature owing partly to the smaller water contents.

If *Ligia* is immersed in the distilled water for about an hour, the body weight is increased and the coagulability of the shed blood is much weaker

Table 2

Effect of water contents[1]

Temperature	No. of experimentals	Time of coagulation in sec.	
		Whole blood	Diluted blood
5°	26	134.0	145.4
15°	25	77.8	116.0
25°	23	65.0	113.5
35°	17	60.0	74.3
40°	14	81.7	165.0
45°	13	210.0	—

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[1] All experimental results are those adapted for 30°C.

than that of a normal one. This fact suggests that the water contents of the animal affect remarkably the blood coagulability in accordance with the temperature.

A series of experiments was carried out as follows; 4–5 drops (about 0.12 cc) blood obtained from the animal was diluted instantly by I drop (0.03 cc) of the distilled water. After thorough mixing the time of coagulation was measured.

As is shown in Table 2, the effect of dilution is the slightest at 35°C, while it is remarkable at both the extreme temperatures 5° and 45°C. The effect of higher temperature being much more intense than that of lower. The limit of dilution for the blood coagulability is about 2.5 times at the optimum temperature of 30°C, (see elsewhere).

Effect of electrolytes

Effect of various electrolytes appeared in company with the temperature on the blood coagulation of *Ligia exotica* was studied. Different amount of three sodium salts, NaBr, $NaNO_2$ and $NaNO_3$ was added to the blood obtained from the animal which was collected in summer, adapted in 30°C and those collected in winter, adapted in 10°C.

Table 3

Effect of electrolytes

Electrolytes added (pH 7.3)	Temperature	Drops of electrolytes added and time of coagulation in sec.							
		1	2	3	4	5	6	8	10
M/8 NaBr	28.0°C (Summer)	47.0	66.3	84.0	530	±	—	—	—
	7.0°C (Winter)	105	120	150	210	270	300	330	600
M/8 $NaNO_2$	28.0°C (Summer)	108	146	360	±	—	—	—	—
	7.0°C (Winter)	120	150	180	240		360	450	540
M/8 $NaNO_3$	27.0°C (Summer)	53.0	94.0	128	170	±	—	—	—
	7.0°C (Winter)	100	150	180	220	260	240	300	390

As is shown in Table 3, the effect of electrolytes is slight in winter and large in summer, and the effect is accompanied with that of dilution which is slight at 28°C, while marked at 7°C as can be judged from the previous result (Table 2).

As far as the amount of the electrolytes added remains small, the time of coagulation in winter is longer than that of summer, while the relation is reverse when a considerable amount is added.

Coagulant enzyme

The crustacean blood coagulation may be induced by the action of the coagulant enzyme though it is quite improbable that the theory of thrombokinase-thrombin-fibrin system of the vertebrates' blood coagulation can wholly be put into the blood of *Ligia.*

By the foregoing temperature experiment on the blood coagulation, it was made clear that the coagulability is strongest at 35°C and becomes weaker with the change of the temperature from that. This tallies well with the general property of the enzyme having the optimum temperature for action near 37°C and its power decreasing with the change of the temperature.

Meanwhile, Costello ('34), Halliburton ('85) and others have proposed the view that the increase of the protoplasmic viscosity with the change of temperature brings about the coagulation of the egg or other cells. To see if the theory can be extended to the blood coagulation, the viscosity change of the blood was measured between 0° and 45°C by Ostwald's viscosimeter and the reciprocal time of the blood taken for flowing down the definite distance was plotted against the temperature. As is shown in Fig. 2, the blood viscosity of *Ligia* decreases with the increase of temperature in a constant curvature, while the coagulation curves have shown caternary in shapes having optimum temperatures near 35°C.

It may be supposed from the curves that the viscosity change of the blood plays an antagonistic rôle upon the blood coagulation. Combining the strongest action of the coagulant enzyme with the low viscosity, the coagulability of the blood at higher than 35°C is considerably large. But the enzymatic action gradually weakens in the higher temperature and the coagulation is suddenly suspended above 46°C. In the lower temperature range, however, the weak enzymatic action suppressing the increased viscosity, the blood remains in the liquid. The antagonistic action of the blood viscosity against the enzymatic action appears most clearly in 30°C adapted animals.

Temperature coefficient

In order to analyse the further effect of temperature on the coagulation, the temperature coefficient was calculated.

Table 4

Temperature coefficient of blood coagulation

Adaptation temperatures	Temperature coefficient					
	Q_{10}		μ		b	
10°C	Q_{15-25}	2.98	μ_{15-25}	18800	b_{5-35}	1.47
	Q_{25-35}	1.80	μ_{25-35}	10800		
	Q_{30-40}	1.47	μ_{30-40}	1900		
	Q_{35-45}	1.00	μ_{35-45}	-2000		
20°C	Q_{10-20}	2.47	μ_{10-20}	17600	b_{5-35}	1.40
	Q_{15-25}	1.73	μ_{15-25}	12500		
	Q_{20-30}	1.71	μ_{20-30}	7200		
	Q_{25-35}	1.43	μ_{25-35}	5000		

	Q_{30-40}	1.04	μ_{30-40}	3500		
	Q_{35-45}	0.82	μ_{35-45}	-4100		
	Q_{5-15}	1.72	μ_{5-15}	8700		
	Q_{15-25}	1.20	μ_{15-25}	3100		
30°C	Q_{25-35}	1.08	μ_{25-35}	1500	b_{5-35}	0.42
	Q_{30-40}	0.77	μ_{30-40}	-11700		
	Q_{35-45}	0.43	μ_{35-45}	-37600		

By the famous equations of Vant'Hoff and Arrhenius modified by Yamamoto ('31), the temperature coefficients Q_{10} and μ were calculated (Table 4).

For the expression of the rate of the biological processes, Bèlehrádek ('26) has proposed another empirical equation, which is $y=\frac{a}{t^b}$, where y being time, t temperature, a and b constants, the latter of which has the meaning of a temperature coefficient.

Previously plotted coagulation curves (Fig. 2) fitted best with this formula below 35°C and three formulae were calculated as follows, $y=\frac{112\cdot10^2}{t^{1.47}}$, $y=\frac{63.1\cdot10^2}{t^{1.40}}$ and $y=\frac{25.7\cdot10}{t^{0.42}}$ for 10°, 20° and 30°C adaptation respectively. Observed and calculated time of the coagulation coincides fairly well (Table 2).

Above 35°C, the data are insufficient to calculate the values of the temperature coefficient.

It would be needless to criticize the theory of the temperature coefficient here, but the variable values of Q_{10} and μ suggests that too complicated phenomena are involved in the coagulation process to be expressed by such equations. Whereas Bèlehádek's formula holds good in this case, yielding a unique b for all temperatures examined. According to him the effect of temperature upon all the biological phenomena might be caused by the viscosity change of the protoplasma.

According to Loeb ('22), the viscosity at a given temperature depends partly on the time elasped from the moment when the solution attained the temperature equilibrium in hydrophilic colloidal solution and the influence of the temperature for adaptation remarkably appears at higher temperature than 40° and lower range than 20°C. Because the coagulant enzyme contained in the blood acts maximum near 37°C, the influence of the adaptation temperature can never appears. On the other hand, the enzymatic power of the blood is much suppressed by the temperature for adaptation at higher and lower ranges previously denoted.

The coagulant action of the enzyme is destroyed at the temperature higher than 46°C and it is irreversible. The effect, on the other hand, does not extinguish at the lower temperature even below 0°C.

Effect of external factors, dilution and electrolyte suggests that they cannot affect the action of the coagulant enzyme near 35°C where the action of the latter is the strongest, whereas the influence of the former is the most remarkable at the temperatures lower than 20°C and higher than 40°C, where the coagulant action of the enzyme is much decreased.

III

Effect of Ions on the Coagulation of the Blood of *Ligia exotica*

It is quite obvious from literatures that the greatest diversity of opinion lies in the rôle played by the calcium on the process of blood coagulation. Still, it is a definite fact that if such anions as oxalate, citrate, and fluoride are added in the blood, the existing ionized calcium might be precipitated forming insoluble salts with them, and the coagulation does not occur. Calcium is thus an indispensable factor in the coagulation of the vertebrates' blood but it is doubtful whether it also plays the same important rôle in the crustacean blood or not.

In the present chapter the following problems are dealt with.

1) Quantitative relation, if any, between various anions added and the solubility of the calcium salts formed combining with the calcium ion present in the blood.

2) The effect of cations, such as alkali, alkali earth and heavy metal ions on the blood coagulation.

As described in the previous chapter, the effect of temperature between 25° and 35°C on the blood coagulation of the warm adapted animal is almost the same. The change of the room temperature of the laboratory was within this range throughout the experiment.

Batesman ('33) found that the blood of *Ligia oceanica* is approximately equal in concentration to the sea water. It may also be true of the blood of *Ligia exotica*. Preliminary experiment on the blood coagulation reveals that the concentration of the experimental salt solution has to be more dilute than that of the sea water, because the dissociation degree of such a concentrated solution is insufficient on one hand and the blood protein is induced to precipitate on the other.

Sodium salts with monovalent, divalent and trivalent anions were dissolved as M/8, M/12 and M/16 solutions respectively, so as they retain isotonicity with each other.

Adding different amount of drops (one drop amounted 0.03 cc) of these solutions measured by the graduated micro-pipette to the blood, the time of coagulation at each dilution and the maximum volume of solutions added without suspending coagulation were measured.

The blood of *Ligia exotica* being slightly alkaline (pH 7.8), the solutions added were controlled as to be pH=7.3 by the addition of N/10 NaOH or HCl. pH was determined colorimetrically using the borax and boric acid mixture and Merck's phenol red being used as an indicator.

Effect of anions

The coagulability of the blood is suspended when it is diluted more than

2.5 times by buffered distilled water (pH 7.3). This is taken as the standard and the effect of various ions on the coagulability is compared. If the coagulation is prevented by the smaller amount of the added solution, it may have an anti-coagulant power, while solutions having an activating power does not coagulate the blood until it is more diluted. These details are summarized in Fig. 3.

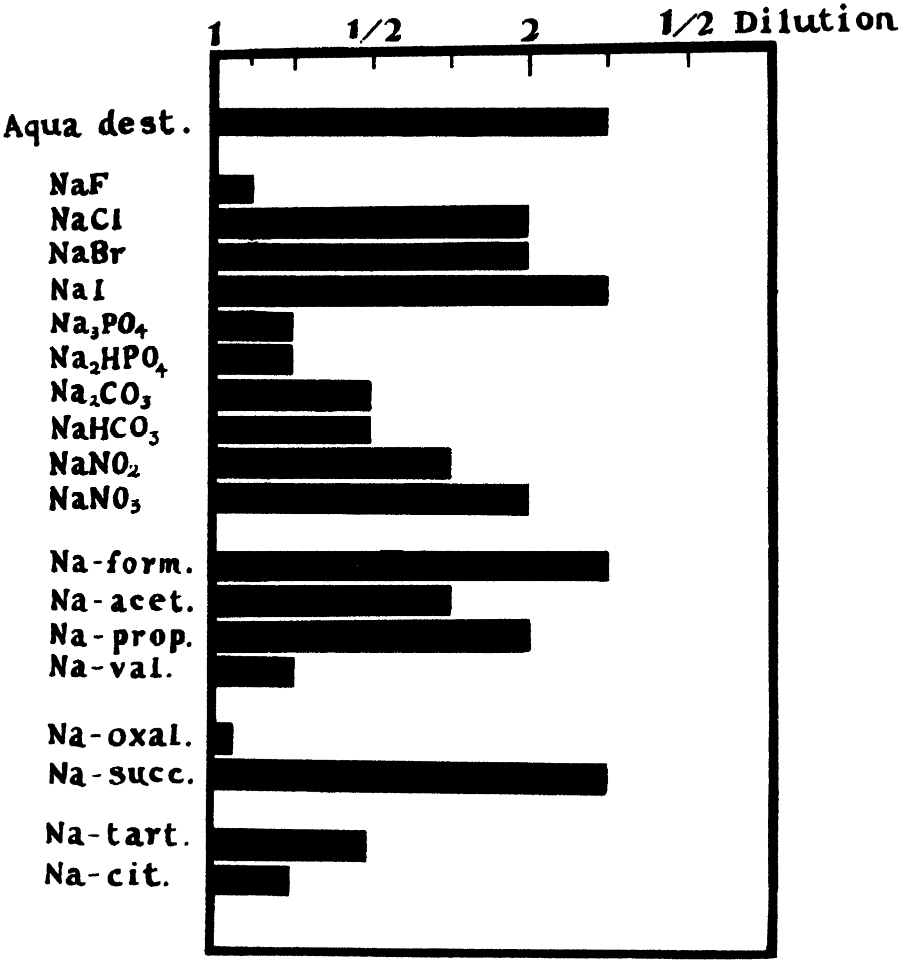

Fig. 3. Limit of coagulation diluted by various sodium salt solutions added. Limit of dilution by dist. water is $2\frac{1}{4}$ times.

a) Effect of inorganic anions: Solutions of sodium salts such as M/8 NaF, NaCl, NaBr, NaI, $NaNO_2$, $NaNO_3$, $NaHCO_3$; M/12 Na_2CO_3, Na_2HPO_4; M/16 Na_3PO_4 were almost neutral, but a small amount of N/10 HCl was added, if neccessary, to bring the pH near 7.3.

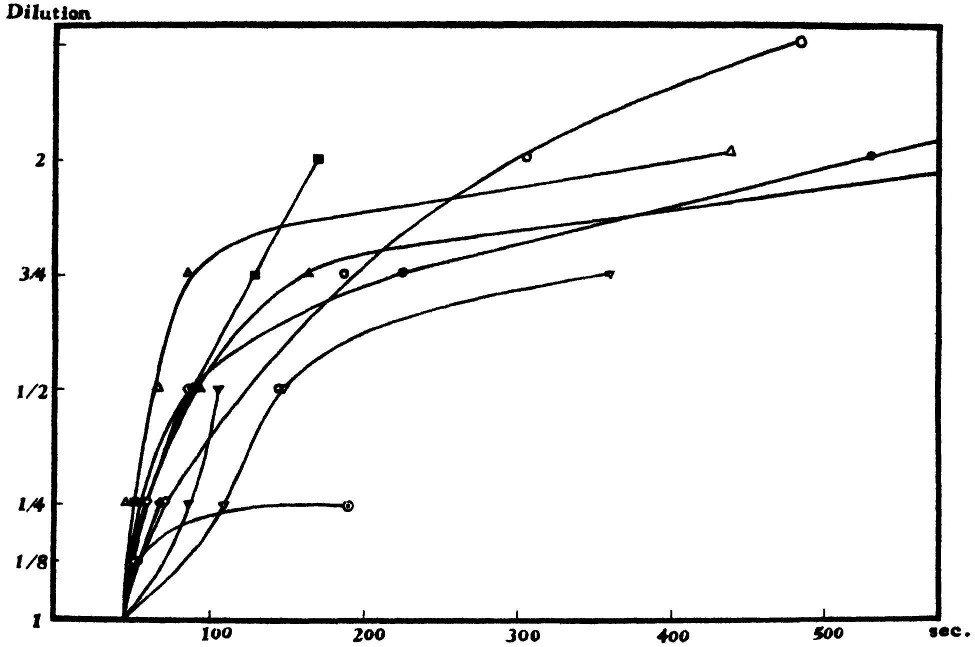

Fig. 4. Curves showing time of blood coagulation diluted by various inorganic anions added (pH 7.3 Temp. 26.0°-30.4°C). ● Aqua dest. ☐ M/8 NaF solution; ▲ M/8 NaCl solution; △ M/8 NaBr solution; ○ M/8 NaI solution; ◉ M/16 Na_3PO_4 solution; ◆ M/12 Na_2HPO_4 solution; ◇ M/12 Na_2CO_3 solution; ▼ M/8 $NaHCO_3$ solution; ▽ M/8 $NaNO_2$ solution; ■ M/8 $NaNO_3$ solution.

When the effect of the solutions of sodium salts combined with halogen series were tested, a slight anti-coagulant power was observed with the exception of fluoride. Moreover, it is conceivable from Fig. 4 that the anti-coagulant power increases with the decrease of the molecular weight. According to the degree of the anti-coagulant action, the halogen anions may be arranged in the following order of series:

$$F' \gg Cl' > Br' > I'$$

The strong anti-coagulant power of fluoride may be ascribed to the lowest solubility of the calcium fluoride formed. On the other hand, chloride, bromide and iodide form calcium salts which are much soluble.

When $NaNO_2$ or $NaNO_3$ solution was added in the blood, both react as a weak anti-coagulant. The effect increases with the decrease of the molecular weight, $NO_2' > NO_3'$. The solubility of the calcium salt formed by NO_2' is a little lower than that of NO_3'.

When the blood was diluted more than 1.5 times by M/8 $NaHCO_3$ or by M/12 Na_2CO_3 solution, the coagulation was perfectly prevented. Calcium carbonate is one of the most insoluble salts, but partially changes to calcium bicarbonate combining with the CO_2 dissolved in the solution as the following equation

$$CaCO_3 + CO_2 + H_2O \rightleftarrows Ca(HCO_3)_2$$

The equilibrium progresses toward right influenced by the partial pressure of CO_2; the solubility of calcium bicarbonate being about 100 times larger than that of calcium carbonate.

The effect of M/12 Na_2HPO_4 or M/16 Na_3PO_4 solution is remarkable. When more than one drop is put into 0.12 cc of the blood, the coagulation is perfectly prevented owing to the insolubility of both $CaHPO_4$ and $Ca_3(PO_4)_2$ formed.

According to the strength of the anti-coagulant power, the inorganic anions except halogen anions may be arranged in the following order of series:

$$HPO_4'' \cdot PO_4''' \gg HCO_3' \cdot CO_3'' \gg NO_2' > NO_3'$$

When a drop of Na_2SO_4 solution is added in the blood, the fibrinogen contained changes instantly into a viscous sticky mass and the true coagulation does not occur.

b) Effect of organic anions: The effect of organic sodium salt solutions, M/8 sodium formate, sodium acetate, sodium propionate, sodium valerianate; M/12 sodium oxalate, sodium succinate, sodium tartrate; M/16 sodium citrate were tested under controlled pH near 7.3.

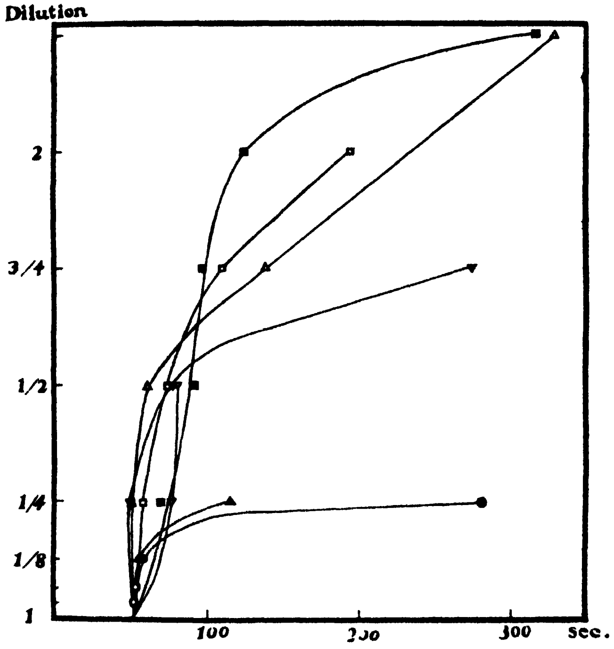

Fig. 5. Curves showing time of blood coagulation diluted by solutions of various organic anions added (pH 7.3, Temp. 25.3°-32.4°C). ■ M/8 sodium formate solution; ▼ M/8 sodium acetate solution; □ M/8 sodium propionate solution; ▲ M/8 sodium valerianate solution; ○ M/12 sodium oxalate solution; △ M/12 sodium succinate solution; ▽ M/12 sodium tartrate solution; ● M/16 sodium citrate solution.

The solubility of the calcium salts formed combining with the fatty acid anions are considerably high, so the anti-coagulant power of the sodium salts added is small. The degree of the anti-coagulant power of them may be roughly proportional to the inverse solubility of their calcium salts, i.e.,

valerianate' ≫ acetate' > propionate' > formate'.

The anti-coagulability of valerianate does not precisely follow the degree of solubility of calcium salts formed. The explanation of the fact may be described later.

When the solution of the sodium salts of the dicarboxylic acids, sodium oxalate or sodium succinate was added in the blood, a distinct difference appeared between them, the former being the strongest anti-coagulant, while the latter hindered the coagulation insufficiently. The calcium oxalate is one of the most insoluble salts, while the calcium succinate is soluble in distilled water more than 1%.

When the solution of the sodium salt of the dioxydicarboxylic acid or the oxytricarboxylic acid, sodium tartrate or sodium citrate was introduced in the blood, the coagulation of the blood was strongly suspended, since the calcium salts transferred from both of the sodium salts are highly insoluble. The anti-coagulant power of them may be arranged in the order of series,

$$\text{oxalate}'' \gg \text{citrate}''' > \text{tartrate}'' \gg \text{succinate}''$$

It may be accepted as proved that the organic anions also have an anti-coagulant power more or less according to the inverse solubility of their calcium salts.

Effect of cations

The effect of cations dissociated from the various metal chlorides are quite diverse according to their chemical properties. The alkali metal ions have a weak anti-coagulant power, and the cations of alkali earth metals excluding barium an activation, while the heavy metal ions show a very different effect according to their own properties.

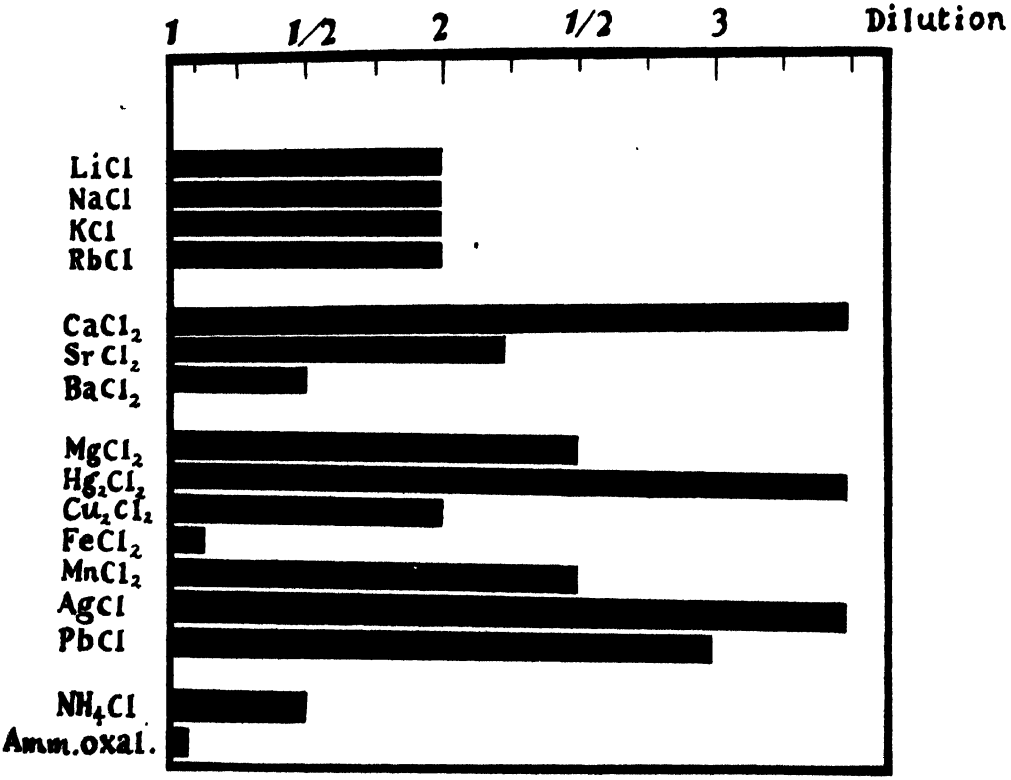

Fig. 6. Limit of coagulation diluted by various metal chloride solutions added.

a) Effect of alkali metal cations: Solutions of alkali metal chlorides M/8 LiCl, NaCl, KCl and RbCl were examined. The cations of alkali metals act as weak anti-coagulants, since the time of the blood coagulation lengthens when these solutions are added. There seems to exist no marked difference between their actions, and the anti-coagulability is quite free from their molecular weights. They may be put into the following order of series: $\mathrm{Na}^{\cdot} > \mathrm{Rb}^{\cdot} \cdot \mathrm{Li}^{\cdot} > \mathrm{K}^{\cdot}$

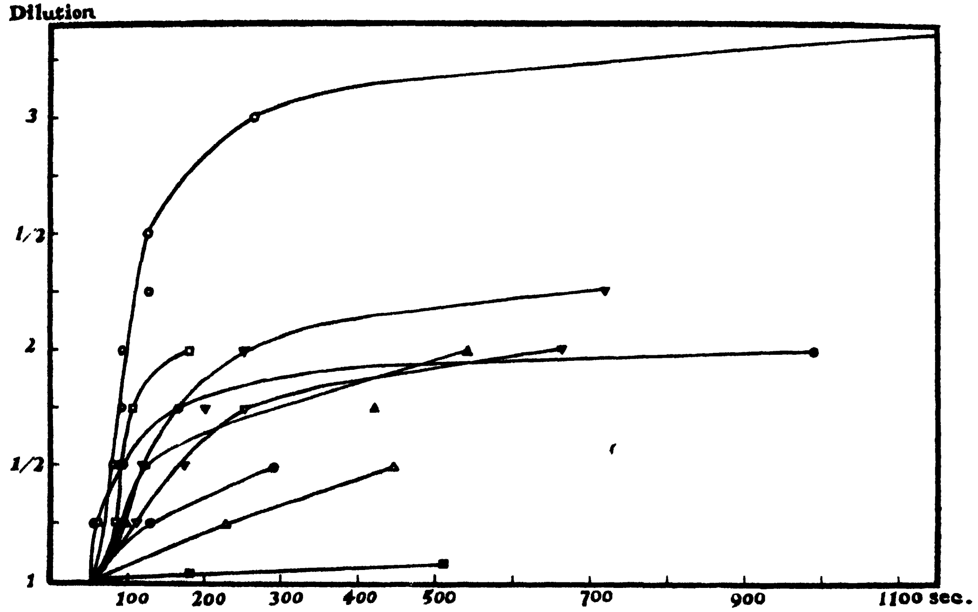

Fig. 7. Curves showing time of coagulation of blood diluted by solutions of various alkali and alkali earth metal cations added (pH 7.3 Temp. 26.6° 31.2°C). ▲ M/8 LiCl solution; ● M/8 NaCl solution; □ M/8 KCl solution; ▽ M/8 RbCl solution; ○ M/12 $CaCl_2$ solution; ▼ M/12 $SrCl_2$ solution; (●) M/12 $BaCl_2$ solution; △ M/8 NH_4Cl solution; ■ M/8 ammonium oxalate solution.

b) Effect of alkali earth cations: Solutions of alkali earth metal chlorides, M/12 $CaCl_2$, $SrCl_2$ and $BaCl_2$ were prepared controlling their pH near 7.3.

When the solution of $CaCl_2$ was introduced into the blood the coagulation was not prevented until it was diluted more than 3.5 times and the white precipitation occured with the increase of the added calcium chloride. The increased coagulability of the blood caused by calcium cannot be substituted by other alkali earth cations.

Strontium ion has shown no conspicuous influence on the coagulation, while barium ion has indicated strong anti-coagulant power. When a little amount of $BaCl_2$ solution was introduced into the blood, white flocky precipitation appeared. This is presumably $BaSO_4$, one of the most insoluble salts formed combining with the SO_4'' contained in the blood.

c) Effect of ammonium ion: Ammonium ion has been known having a similar effect with that of alkali metal ions on many biological processes.

When the solution of M/8 NH_4Cl was put into the blood the coagulability of the blood was markedly decreased. The $NH_4^{\cdot}$ has a stronger anti-coagulant power than any other alkali metal cations.

When the solution of M/12 ammonium oxalate, the salt formed combining both the strongest anti-coagulant anion and the cation, was introduced into the blood, there is displayed no stronger anti-coagulant effect than in the case of sodium oxalate.

d) Effect of metal ions: Almost all the solutions of the metal chlorides show a strong acidity caused by hydrolysis. Owing to lower pH than 2.5 of the solutions of $FeCl_6$, $CuCl_2$, $SnCl_2$, $SnCl_4$, $HgCl_2$, $SbCl_3$ and $AlCl_3$ the fibrinogen or other protein factors contained in the blood was instantly transferred into the sticky masses.

Solutions of $CdCl_2$, $CrCl_3$, $ZnCl_2$, $CoCl_2$, and $NiCl_2$ also changed the blood into the viscous masses in spite of their less severe acidities. Adding less than 5 per cent in volume of N/10 NaOH solution into the solutions of M/8 AgCl, PbCl Hg_2Cl_2 and Cu_2Cl_2; M/12 $FeCl_2$ and $MnCl_2$ they were brought near pH 7.3. Also the effect of M/12 $MgCl_2$ was experimented.

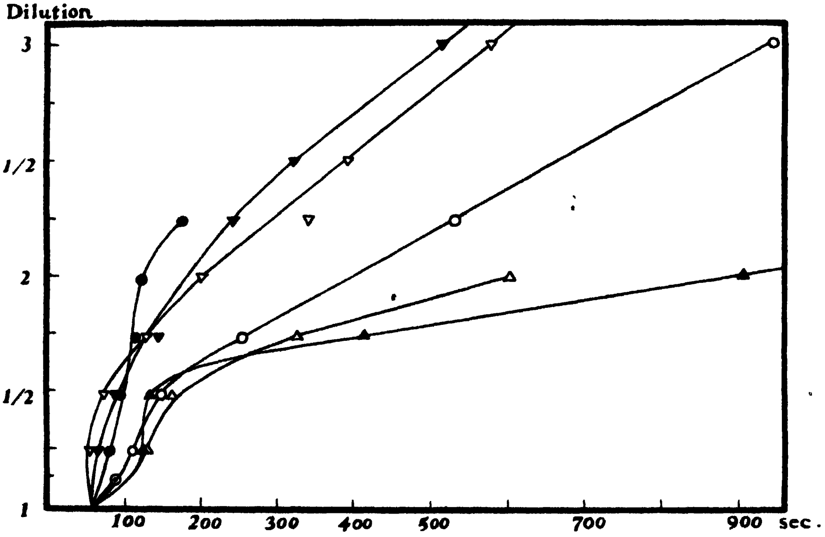

Fig. 8. Curves showing time of dlood coagulation diluted by various metal cations added (pH 7.3 Temp. 26.0°–29.5°C). ▽ M/8 AgCl solution; ○ M/8 PbCl solution; △ M/8 Cu_2Cl_2 solution; ▼ M/8 Hg_2Cl_2 solution; ◉ M/12 $FeCl_2$ solution; ● M/12 $MgCl_2$ solution; ▲ M/12 $MnCl_2$ soluiton.

Generally speaking, the metal ions have an activating power for the coagulation more or less except $Fe^{\cdot\cdot}$ which acts as a strong anti-coagulant. As is shown in Fig. 8 $Hg^{\cdot}$ and $Ag^{\cdot}$ having a strong activating power like that of calcium, while $Pb^{\cdot\cdot}$, $Mn^{\cdot\cdot}$ and $Mg^{\cdot\cdot}$ are the less activators. $Cu^{\cdot}$ showing a slight anti-coagulant power as alkali metal ions.

The degree of anti-coagulant action may be summarised as the following order of series,

$$Hg^{\cdot} \cdot Ag^{\cdot} \gg Pb^{\cdot} > Mn^{\cdot\cdot} > Mg^{\cdot\cdot} > Cu^{\cdot} \gg Fe^{\cdot\cdot}$$

e) Effect of sea water: Sea water is composed of strong activators as $Ca^{\cdot\cdot}$ and $Mg^{\cdot\cdot}$ with weak anti-coagulants as $Na^{\cdot}$, $K^{\cdot}$, Cl' and SO_4''. The total concentration of the salts in sea water is higher than the test solutions of the present experiment, since it corresponds to about 5M/8 NaCl solution.

Sea water (pH 8.25) has a strong power for activating the coagulation (Fig. 9). This may be due to the fact that a slight calcium content suppresses the large amount of the anti-coagulant dissolved in the blood.

Effect of pH

The profound influence of the hydrogen ion upon the blood coagulation has been demonstrated, and the coagulation is said to be relatively resistant to the change of pH of added salt solution.

Solutions of sodium salts with varying pH was obtained by the addition of N/10 HCl or NaOH. When a weak alkaline solution of $NaHCO_3$ (pH 8.25), $NaNO_2$ (pH 9.0) or NaCl (pH 9.0) is added in the blood, the time of coagulation is slightly accelerated and the coagulability also increased (Fig. 9), while the solution of Na_2CO_3 which shows more intense alkalinity (pH 10.0) decreases the coagulability. The action of weak acidic solution is rather conspicuous; the saline solution slightly acidified increases the coagulability much.

It is noticeable that in pure salt solutions, slight change of pH (6.0–9.0) induces the coagulation, while strong alkaline solution (pH 10.0) decreases the coagulability.

Table 5

Effect of pH of various sodium salt solutions on blood coagulation. Time of coagulation in sec.

Solutions added	pH	Degree of dilution (no. of drops added)				
		$1\frac{1}{4}$ (1 drop)	$1\frac{1}{2}$ (2 drops)	$1\frac{3}{4}$ (3 drops)	2 (4 drops)	$2\frac{1}{4}$ (5 drops)
M/8 $NaHCO_3$	7.4	86.0	106	—		
	8.25	52.0	97.0	273	—	
M/8 NaCl	6.0	51.0	71.0	75.0	92.0	200
	7.3	54.0	94.5	163	990	—
	9.0	40.0	88.0	123	300	-
M/8 $NaNO_2$	7.4	108	146	360	—	
	8.4	43.0	77.0	120		
M/12 Na_2CO_3	7.2	56.0	86.0	-		
	10.0	69.0	127	—		

In order to compare the effect of mixed salt solution, the effect of varying pH of sea water was determined. A series of sea water, their pH being from 3.0 to 11.0 were prepared by the same method described before.

When the change of pH is slight (6.15–8.25), the mode of coagulation is not altered. (Table 6 and Fig. 9). The increase of pH up to 9.6 remarkably decreases the time of coagulation though the coagulability is not affected, while by the decrease of pH down to 3.0, it is markedly increased.

Table 6

Effect of pH of sea water on blood coagulation.
Time of coagulation in sec.

pH	Degree of dilution (no. of drops added)							
	$1\frac{1}{4}$ (1 drop)	$1\frac{1}{2}$ (2 drops)	$1\frac{3}{4}$ (3 drops)	2 (4 drops)	$2\frac{1}{4}$ (5 drops)	$2\frac{1}{2}$ (6 drops)	3 (8 drops)	$3\frac{1}{2}$ (10 drops)
3.0	58.0	115	175	192	310	355	510	1200
6.15	66.0	112	130	194	420	600	—	—
7.4	93.0	115	147	172	275	530	—	—
8.25	45.0	71.0	74.0	106	255	680	—	—
9.6	43.0	65.0	120	150	170	190	—	—
11.0	40.0	70.0	108	135	165	210	—	—

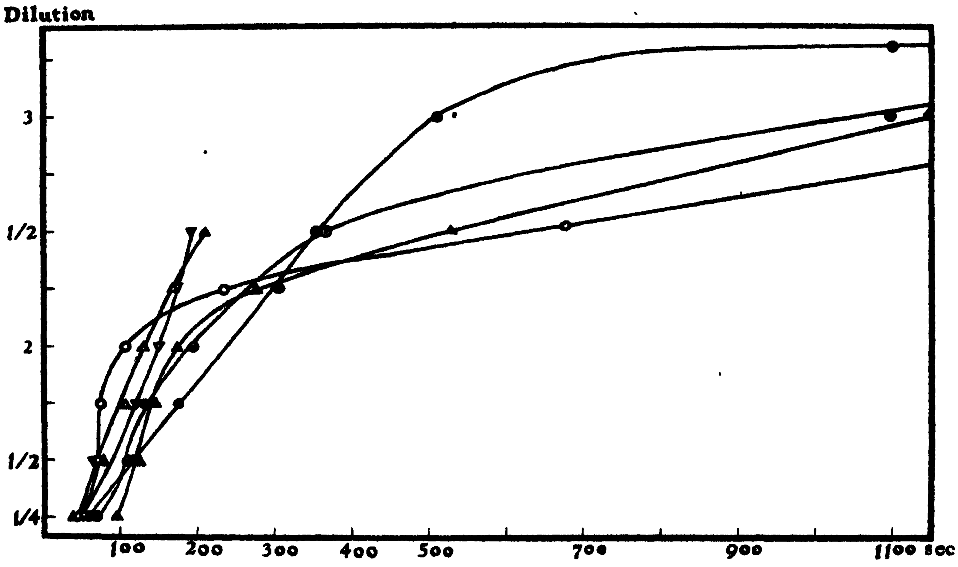

Fig. 9. Curves showing time of blood coagulation caused by varying pH of sea water (Temp. 30.2°–31.5°C). ● for 3.0; ◉ for 6.25; ▲ for 7.3; ○ for 8.25; ▽ for 9.6; △ for 11.0.

Generally speaking, the blood coagulation is not disturbed in the favorable range of acid and alkaline reaction. On the contrary, both the time of coagulation and the coagulability are strongly inhibited out of this range.

Anions

It is made clear in the present study that the prevention of the blood coagulation caused by various sodium salt solutions added is brought forth by the extinction or diminution of the concentration of calcium ions existing in the blood by the formation of insoluble calcium salts, since the concentrations of the solutions added are very low and all of them are the strong electrolytes (more than 80% is ionized).

The anti-coagulant degree of various inorganic anions dissociated from the sodium salts is to be arranged in the following order of series:

$$F' \gg HPO_4'' \cdot PO_4''' \gg HCO_3' \cdot CO_3'' \gg NO_2' > Cl' > Br' > NO_3' \geq J'$$

Moreover, simple relation exists between the anti-coagulability of the sodium salts tested and the solubility of the calcium salts formed, as is shown in Table 7 and Fig. 10.

Table 7

Relation between limit of coagulant power of diluted blood by adding various sodium salt solutions and solubility of calcium compounds formed with calcium ion existing in blood of *Ligia exotica*

Sodium salt solutions	Limit of dilution	Formed Calcium compound	Solubility in % at 30°C[1]
M/8 NaF	$1\frac{1}{8}$	CaF_2	18.0×10^{-4}
M/8 NaCl	2	$CaCl_2$	49.9
M/8 NaBr	2	$CaBr_2$	62.5
M/8 NaI	$2\frac{1}{4}$	CaI_2	68.3
M/16 Na_3PO_4	$1\frac{1}{4}$	$Ca_3(PO_4)_2$	$36.0\times10^{-}$[illegible]
M/12 Na_2HPO_4	$1\frac{1}{4}$	$CaHPO_4$	$23.0\times10^{-}$[illegible]
M/12 Na_2CO_3	$1\frac{1}{2}$	$CaCO_3$ and $Ca(HCO_3)_2$ are coexisted	52.0×10^{-4}
M/8 $NaHCO_3$	$1\frac{1}{2}$	$Ca(HCO_3)_2$	16.0×10^{-2}
M/8 $NaNO_2$	$1\frac{3}{4}$	$Ca(NO_2)_2$	47.0
M/8 $NaNO_3$	2	$Ca(NO_3)_2$	59.4
M/8 Na-form.	$2\frac{1}{4}$	Ca-form.	16.8

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[1] Interpolated values from Randolt-Bernstein's chemical table

M/8 Na-acet.	$1\frac{3}{4}$	Ca-acet.	33.8
M/8 Na-prop.	2	Ca-prop.	39.1
M/8 Na-n-val.	$1\frac{1}{4}$	Ca-val.	84.0×10^{-1}
M/12 Na-oxal.	$1\frac{1}{16}$	Ca-oxal.	63.0×10^{-5}
M/12 Na-succ.	$2\frac{1}{4}$	Ca-succ.	12.5×10^{-1}
M/12 Na-tart.	$1\frac{1}{2}$	Ca-tart.	44.0×10^{-5}
M/16 Na-cit.	$1\frac{1}{4}$	Ca-cit.	96.0×10^{-5}

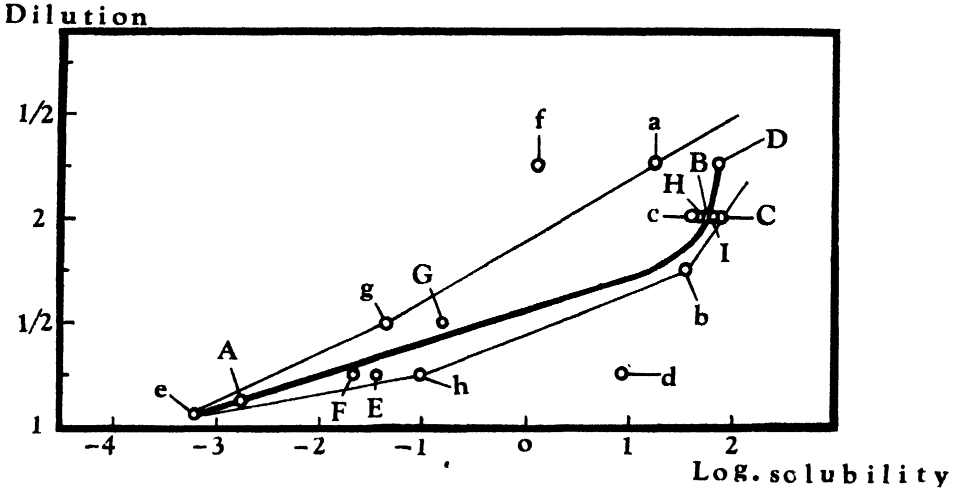

Fig. 10. Relation between anti-coagulant action of various anions dissociated from sodium salts and log. per cent solubility of formed calcium compounds.
A, F′; B, Cl′; C, Br′; D, I′; E, PO_4'''; F, HPO_4''; G, HCO_3'; H, NO_2'; I, NO_3'; a, formate′; b, acetate′; c, propionate′; d, valerianate′; e, oxalate″; f, succinate″; g, tartrate″; h, citrate‴.

The anti-coagulant effect of various organic anions tested as the sodium salts may be put into the following order:

oxalate″ ≫ citrate‴•valerianate′ ≫ tartrate″ ≫ acetate′
> propionate′ > succinate″ > formate′

The anti-coagulability of the sodium salts combined with organic anions is also inversely proportional to the solubility of the formed calcium compound excluding a few cases.

As is shown in Fig. 10, the limit of coagulant power of the diluted blood by the addition of the various sodium salt solutions is plotted against the log. solubility of the formed calcium compounds with the calcium ion existing in the blood, where sodium valerianate shows stronger anti-coagulant power than the insolubility of its calcium salts, while the relation is reversed in the case of sodium succinate.

A similar case was explained by Loeb ('22) in his experiment of contact irritability in muscle. He states that it is due to presence of free HO ions that solution of sodium valerianate gives rise to a slight degree of contact irritability in muscle, although calcium valerianate is soluble. If we diminish the alkalinity of a sodium valerianate solution by adding a small amount of free valerianic acid, it no longer produces the contact irritability in muscle.

In the present case, however, the condition differs slightly and the above explanation cannot be applied, since the pH of the solution used is always 7.3 throughout the observation.

Table 8

Formation of calcium precipitate in blood after various sodium salt solutions were added

(pH 7.3, Temp. 25.0°C)

Sodium salt solutions	Formation of calcium precipitate
M/8 NaF	++
M/8 NaCl	−
M/8 NaBr	−
M/8 NaI	−
M/16 Na_3PO_4	+
M/12 Na_2HPO_4	+
M/12 Na_2CO_3	−
M/8 $NaHCO_3$	−
M/8 $NaNO_2$	−
M/8 $NaNO_3$	−
M/8 Na-form.	±
M/8 Na-acet.	−
M/8 Na-prop.	−
M/8 Na-val.	+
M/12 Na-oxal.	++
M/12 Na-succ.	−
M/12 Na-tart.	−
M/16 Na-cit.	−

When sodium salts whose anions being strong calcium precipitants are added in the blood, there occurs a white precipitant instantly. This was affirmed as the calcium salts by analyses of Kramer and Tisdall's method ('21).

As is shown in Table 8, sodium valerianate also calls upon the strong precipitation in spite of the high solubility of the calcium valerianate. This may be explained by the change of the calcium content of the blood before and after coagulation on which my later study will refer.

The graphical illustration of Fig. 10 shows that the relation between the anti-coagulability of anions derived from various sodium salts added and the log. per cent solubility of the calcium compound formed in the blood is almost rectilinear so far as the small amount of strong anti-coagulant solution is concerned, while the weak anti-coagulant action of the distilled water has buffer action, when the large amount of weak anti-coagulant solution is introduced.

Cations

It is a well known fact in biology that the alkali metal ions have an antagonistic action against the alkali earth ions and it is also true in the blood coagulation, since the increase of the alkali metal ions in the blood causes a slight decrease of coagulability. But the anti-coagulant action quite differs from that of calcium precipitant anions. The anti-coagulant power of alkali metal cations against calcium ion is due to the antagonistic action between them not precipitating the latter. This may be cleared by the addition of ammonium oxalate solution into the blood where the strong antagonistic action of $NH_4^{\cdot}$ and the anti-coagulant action of oxalate$''$ do not act in the same manner and the anti-coagulability is not superior to the effect of sodium oxalate.

When calcium is put into the blood, supersaturation of it occurs in the blood and the superfluous calcium begins to precipitate, so the limit of coagulation is largest suppressing the anti-coagulant effect of dilution. According to Stuber and Sano ('21), $Sr^{\cdot\cdot}$ can bring the oxalated calcium-free blood to coagulation, while $Ba^{\cdot\cdot}$ and $Mg^{\cdot\cdot}$ can not. They arranged the coagulant power of divalent cations for the oxalated blood as follows: $Ca^{\cdot\cdot}>Sr^{\cdot\cdot}>Ba^{\cdot\cdot}=Mg^{\cdot\cdot}$ and concluded that the capacity of inducing coagulation is inversely proportional to the solubility of the formed alkali earth oxalates.

In the present investigation, however, the effect of strontium for the blood coagulation is quite indifferent; it does not show any anti- or activating power for coagulation, while a drop of barium solution introduced into the blood produces a white precipitate of $BaSO_4$ and the blood coagulation is prevented intensely.

The rôle of calcium in the blood coagulation is unique and cannot be substituted by any other cations. According to the experiment of Stuber and Sano, the action of $Sr^{\cdot\cdot}$, $Ba^{\cdot\cdot}$ and $Mg^{\cdot\cdot}$ for the oxalated blood has no effect on $Ca^{\cdot\cdot}$ but on oxalate$''$ coexisting in the blood, so the coagulability has a contact relation with the solubility of formed alkali earth oxalate.

Meanwhile, Loeb ('07) states that the coagulation of the diluted blood of *Hummerus* is called upon by adding $SrCl_2$ or $BaCl_2$ instead of $CaCl_2$, while $MgCl_2$ and alkali metal chlorides can not. In the present study, however, no particular effect is observed when $Sr^{\cdot\cdot}$ is introduced into the blood where $Ca^{\cdot\cdot}$ is contained normally. On the other hand, the breaking down of the ionic balance by severe precipitation of $BaSO_4$ after $Ba^{\cdot\cdot}$ is added, may cause some disturbance on the coagulating process.

Fischer and Schmitz ('33) states that incoagulable blood after being treated by N/10 potassium oxalate, is induced to coagulate by adding $CaCl_2$, while it can not be coagulated by the addition of an equivalent amount of $AgNO_3$. $Ca^{\cdot\cdot}$ can not be replaced by $Ag^{\cdot\cdot}$ in the oxalated blood. On the other hand a small amount of $AgNO_3$ can induce the heparinized incoagulable blood to coagulate instantly. So they concluded that normal ions have influence over the anti-coagulant action of heparin and not on the blood component itself. They arranged metal ions in a series according to their anti-heparin effect as follows:

$$Hg>Ag>Cu>Au>Cd>Mg>Pt>Zn>Co>Ca>Ba>Fe^{\cdot\cdot}\cdot Fe^{\cdot\cdot\cdot}\cdot Al\cdot Mn$$

Generally speaking, the metal ions behave as an activator on the coagulation in the blood of *Ligia* where normal amount of $Ca^{\cdot\cdot}$ exists. When the blood is diluted by the metal chloride solutions, the insufficiency of $Ca^{\cdot\cdot}$ may be compensated by the metal ions and the blood coagulation is attained successively. $Mg^{\cdot\cdot}$, the indispensable factor of sea water can also activate the coagulability of the blood markedly. The degree of the activating power may be arranged in the following order of series, $Hg^{\cdot} \cdot Ag^{\cdot} \gg Pb^{\cdot} > Mn^{\cdot\cdot} > Mg^{\cdot\cdot} > Cu^{\cdot} > Fe^{\cdot\cdot}$. This series shows quite an exact coincidence with Fischer's.

IV

Anti-coagulant Action of the Hepato-pancreas of *Ligia exotica*

A blackish brown fluid obtained after the autolysis of the hepato-pancreas of *Ligia exotica* shows a strong anti-coagulant power for the blood of not only its own species but other crustaceans also. In the present chapter, a part of the physiological effect displayed by the fluid is dealt with.

Two pairs of yellowish brown tubular hepato-pancreas occupies the coelomic space of *Ligia exotica*. When the animal is dissected and the organ is exposed in the air, it begins to autolize. The organ is also changed into the fluid in situ soon after the death of the animal.

Hepato-pancreas dissected out is ground in the bowl and filtered by the cloth. Instead of this procedure, free autolysis during a day or two perfectly liquefies the organ. The filrate thus obtained is a viscous blackish brown fluid with metallic luster which shows no change after the elapse of a year in the laboratory. The filtrate will be called under the name of "hepato-pancreatic fluid" in the present paper.

Properties of the hepato-pancreatic fluid

The specific gravity of the hepato-pancreatic fluid thus prepared is measured by using the specific bottle of 55 cc capacity. The average value of 5 measurements is 1.0871 at 18°C.

The freezing point of the fluid is determined by Beckmann's thermometer graduated up to 0.01°C. The average value of 5 measurements is -8.42°C. The cooling curve of the fluid after immersion in the cooling mixture of ice and water e. i. ca -10.5°C, is shown in Fig. 11. The gradual transformation of the fluid into ice and the extremely low freezing point might suggest that the larger part of the solvent being the oily solution and not the water.

The pH of the fluid is determined potentiometrically using the hydrogen ion meter with antimon electrode manufactured by Yokogawa Denkiseisakusho Ltd. The full description of the apparatus may appear in a later paper. The pH of the hepato-pancreatic fluid differs according to the procedure of preparation; the average value of the fluid prepared by grinding the crude hepato-pancreas is 5.75, while that of those obtained by the perfect autolysis after the elapse of 24 hours shows 4.18.

In the present experiment, the fluid obtained by free autolysis only is used.

Hydrolysis with dilute mineral acids as hydrochloric, nitric and sulfuric

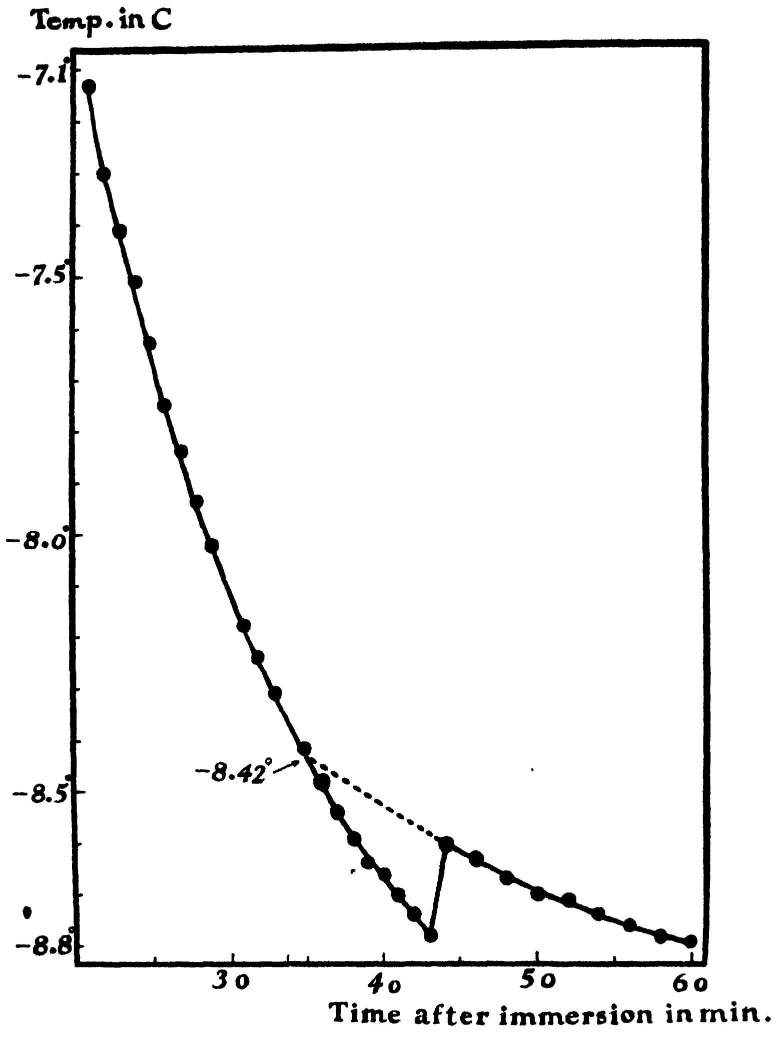

Fig. 11. Cooling curve of hepato-pancreatic fluid after immersion in -10.5°C water. Freezing point is determined graphically as -8.42°C.

destroys the anti-coagulant action, while with dilute alkali no prevention of it occurs.

Coagulant action of the hepato-pancreatic fluid

One drop (0.03 cc) of 1/10 hepato-pancreatic fluid (1 part of the fluid is diluted by 9 parts of the distilled water) can suspend the coagulation of ten drops of blood, while one drop of 1/100 fluid being sufficient to retard the time of coagulation of four drops of blood. The power of preventing the blood coagulation is of the order of 1 to 100, while 1 to 400 for retarding the time of coagulation. The anti-coagulant action is almost the same order with that of sodium oxalate, the strongest anti-coagulant (see elsewhere).

Hepato-pancreatic fluid is effective also in vivo as in vitro. When 0.01 cc of the fluid is injected intraperitoneally into normal *Ligia* of the largest male, the blood obtained from it is rendered wholly incoagulable for a period of about half an hour. Specimens withdrawn after this time has shown imperfect clotting in an hour.

The hepato-pancreatic fluid of *Ligia* can prevent the blood coagulation of other crustacea though the action is much diminished. The blood of the common shore crabs, *Xanthodius distinguendus*, *Sesarma dehaani*, *S. haematocheir* and *Panulirus japonicus* is clotted by the addition of a small amount of the hepato-pancreatic fluid of *Ligia*. Also the blood of *Ligia* can be coagulated by the extract of their hepato-pancreas when introduced. While, the blood of the Japanese giant crab, *Macrocheira Kaempferi* can never be coagulated by the added hepato-pancreatic fluid and the blood of *Ligia* also remains incoagulable by the hepato-pancreatic extract of the crab. The anti-coagulant action of the hepato-pancreatic fluid on the blood of fishes such as *Lateolabrax japonicus*, *Girella punctata* and *Mugil cephalus* and the blood incoagulability of *Ligia* caused by the liver extract of the fishes was quite vague as is shown in Table 9.

Table 9

Specificity of hepato-pancreatic fluid of *Ligia exotica*

Materials used	Anti-coagulant power of hepato-pancreatic fluid of *Ligia exotica*	Blood incoagulability of *Ligia exotica* by extract of hepato-pancreas or liver
Crustacea		
Xanthodius distinguendus	++	+
Sesarma dehaani	++	+
S. haematocheir	++	+
Macrocheira Kaempferi	—	—
Panulirus japonicus	++	+
Pisces		
Lateolabrax japonicus	±	±
Girella punctata	±	±
Mugil caphalus	±	±

The anti-coagulant action of the hepato-pancreatic fluid is not destroyed by prolonged boiling, while 1/10 fluid is affected more or less by temperature as is shown in Table 10.

The anti-coagulant power of 1/10 fluid is diminished about one half after 20 minutes boiling. Treatment of the fluid at 64°C for 30 minutes and at 55°C for an hour also decreases the anti-coagulant power slightly, while an hour's cooling at −15°C can not destroy the power notwithstanding the fluid is perfectly frozen.

Table 10

Effect of temperature on anti-coagulant action of 1/10 hepato-pancreatic fluid

Treatment	Time of coagulation in min. (one drop of 1/10 fluid is introduced in diff. amount of blood)				
	6 drops	8 drops	10 drops	15 drops	20 drops
Control at 30.4°C.			—	6.25	4.5
Boiled 20 min.	—	10.5	7.5		
30 min. at 64°C.			6.5		
An hour at 55°C.			3.3	2.3	
An hour at -15°C.			—	9.0	5.5

Adding one drop of the hepato-pancreatic fluid diluted between 50–10000 times in four drops of the blood, the optimum temperature for action and the limit of dilution of the hepato-pancreatic fluid is determined.

Table 11

Optimum temperature for the action and the limit of dilution of hepato-pancreatic fluid

Time of coagulation in sec.

Dilution / Temperature	1/50	1/100	1/500	1/1000	1/5000	1/10000
5°	345.0	205.0	160.0	145.0	145.0	147.0
15°	230.0	165.0	140.0	133.5	120.0	116.5
25°	227.5	134.0	126.0	120.0	110.0	116.5
35°	102.5	74.0	71.0	68.0	66.5	67.0
40°	—	183.5	170.0	145.0	146.5	140.0
45°	—	—	—	—	—	—

As is shown in Table 11, the blood at 45°C does not coagulate owing to the weak resistant power against temperature. The anti-coagulant action of the hepato-pancreatic fluid is maximum between 15–25°C, since 1/1000 fluid can prolong the coagulation considerably despite the fact that the effect of temperature on the coagulation is minimum at 35°C. The concentration effect of the fluid does not appear at 35°C, while it is remarkable at 5°C (Fig. 12).

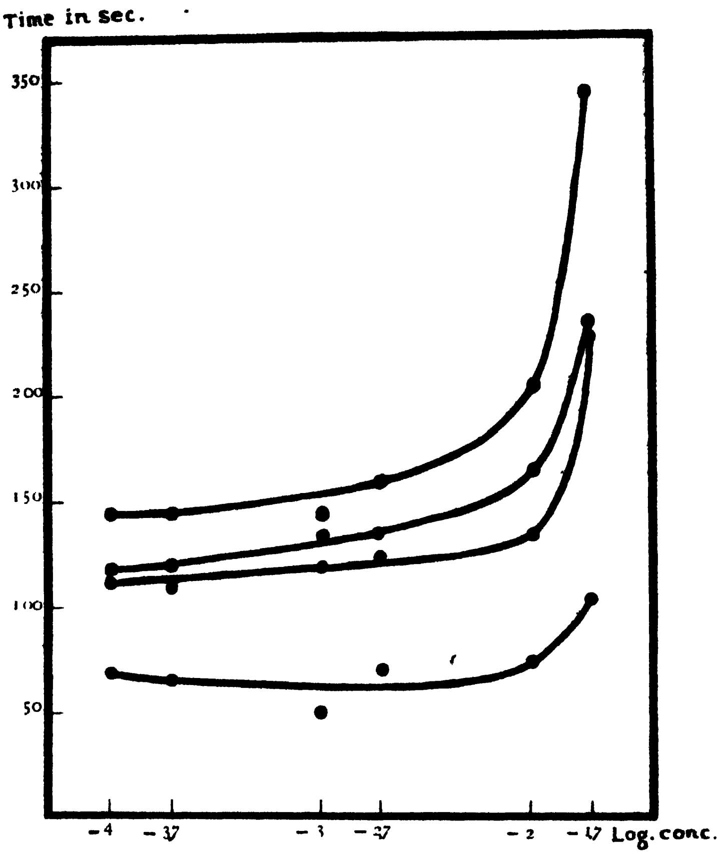

Fig. 12. Concentration effect of hepato-pancreatic fluid on anti-coagulant action at different temperatures. Upper at 5°; upper middle at 15°; lower middle at 25°; lower at 35°C respectively.

Antagonistic Action between Calcium and Hepato-pancreatic Fluid

When different number of drops (one drop = 0.03 cc) of M/12 $CaCl_2$ solution is added with one drop of 1/50 hepato-pancreatic fluid into four drops of

Table 12

Antagonistic action between hepato-pancreatic fluid and calcium chloride solution at 30°C

Concentration of hepato-pancreatic fluid (1 drop)	Time of coagulation in sec. Drops of M/12 $CaCl_2$ solution added in 4 drops of blood plus 1 drop of hepato-pancreatic fluid			
	1 drop	2 drops	3 drops	4 drops
1/50	—	—	—	—
1/100	73.0	70.0	89.0	135

the blood, no clotting is induced as is shown in Table 12, while $CaCl_2$ with 1/100 fluid brings about strong coagulation in a short time. Comparing these results with Table 11, it may be concluded that the coagulant action of calcium is wholly suppressed by the anti-coagulant action of the hepato-pancreatic fluid.

Anti-coagulability of hirudin and heparin for the blood of *Ligia*

a) Anti-coagulant action of heparin: Heparin powder of Kahlbaum is dissolved by distilled water. One drop of 0.5% heparin solution added into four drops of the blood, retards the time of coagulation remarkably, while 1% solution keeps the blood perfectly incoagulable. The degree of the anti-coagulant action is of the order of 1 : 400. For the sake of comparison it is here noted that according to Howell ('22), the anti-coagulant action of heparin for human blood is of the order of 1 mg to 100 cc (1 : 100000).

b) Anti-coagulant action of hirudin: Hirudin solution is prepared dissolving hirudin powder of Kahlbaum by distilled water. The blood of *Ligia* is made incoagulable by 1% solution, the anti-coagulant power is of the order of 1 : 400.

Anti-coagulant substance

In the present study, the properties of the anti-coagulant substance contained in the hepato-pancreatic fluid is determined, but judging from the physiological reaction displayed therein, it may be quite an analogous substance with heparin extracted from the dog liver by Howell ('22).

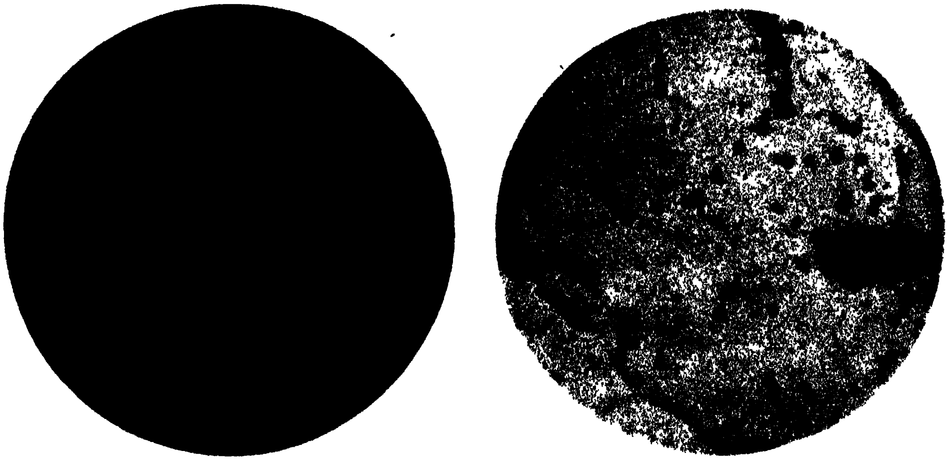

Fig. 13. Photograph showing normal blood coagulation (left) and incoagulated blood by addition of hepato-pancreatic fluid (right). ×600

According to Bancroft and others ('35), heparin likewise hirudin seems to be an anti-thrombin. It may be inferred at least from the present investigation that the anti-coagulant action of the hepato-pancreatic fluid is not attributable to the calcium precipitant action, since no precipitate was formed during the process.

When incoagulated blood by the hepato-pancreatic fluid is observed under the microscope, remarkable difference is seen from that of normal clotting as is shown in Fig. 13.

An explosive cell which, as described by Tait ('20), is presumed to set free thrombin or such coagulant is never formed in the heparinized blood.

SUMMARY

1) The mode of blood coagulation of *Ligia exotica* adapted at different temperatures, 10°, 20° and 30°C differs slightly from each other. But all the temperature coagulation curves drawn are caternary in shapes having optimum temperatures for action near 35°C, while the temperature viscosity curve plotted under the same condition denotes quite an antagonistic expression. The effect of the external factors as electrolytes and water contents of the blood and the limit of temperature for coagulation reveal clearly that the precess of the coagulation is more or less induced by the coagulant enzyme contained in the blood.

The variability of the temperature coefficients Q_{10} and μ of the blood coagulation shows the complicity of the process involved, but the unique applicability of b of Bělehrádek's equation suggests that the process has some correlation with the physical changes.

2) The blood coagulation of *Ligia exotica* is inhibited when it is diluted more than 2.5 times by buffered distilled water (pH 7.3).

3) The anti-coagulant action of the anions may be caused by the diminution or extinction of the concentration of calcium ions existing in the blood forming insoluble calcium salts.

The degree of the anti-coagulant power of various inorganic anions dissociated from sodium salts is arranged in the following order of series:

$$F' \gg HPO_4'' \cdot PO_4''' \gg HCO_3' \cdot CO_3'' \gg NO_2' > Cl' > Br' > NO_3' > J'$$

The anti-coagulant action of the organic anions examined as the sodium salts may be put in the following arrangement:

oxalate'' $\gg$ citrate'''•valerianate' $\gg$ tartrate'' $>$ acetate' $>$ propionate'
$>$ succinate'' $>$ formate'

The relation between the anti-coagulability of the anions derived from sodium salts and the log. per cent solubility of the calcium compounds formed in the blood is almost rectilinear.

4) When sodium salts whose anions are strong calcium precipitants are added in the blood, there occurs instantly a white precipitate which is affirmed as the calcium compound by analysis.

5) The anti-coagulant action of the alkali metal cations quite differs from that of the calcium precipitant anions. The anti-coagulant action of the former is, perhaps, due to the antagonistic action against calcium not precipitating it. The alkali earth cations on the other hand have an activating action more or less excluding Ba, which acts as a strong anti-coagulant precipitating SO_4'' forming an insoluble $BaSO_4$. The anti-coagulant power of the alkali and alkali

earth cations may be arraged in the following manner:

$$Ba^{\cdot\cdot} > Na^{\cdot} > Rb^{\cdot} \cdot Li^{\cdot} > K^{\cdot} > Sr^{\cdot\cdot} > Ca^{\cdot\cdot}$$

6) Metal ions behave as strong coagulants except $Cu^{\cdot}$ and $Fe^{\cdot\cdot}$, since the blood coagulability is increased by the addition of these ions compensating the insufficient effect of the calcium. $Mg^{\cdot\cdot}$, a component of the sea water also activates the coagulability of the blood remarkably. The degree of the activating power may be arranged in the following series: $Hg^{\cdot} \cdot Ag^{\cdot} \gg Pb^{\cdot} > Mn^{\cdot\cdot} > Mg^{\cdot\cdot} > Cu^{\cdot\cdot} > Fe^{\cdot\cdot}$. This series shows an exact coincidence with Fischer's.

7) It is noted in the pure sodium salt solutions that the slight change of pH (6.0–9.0) increases the coagulant power, while strong alkaline (pH 10.0) decreases the coagulability. The blood coagulation is not disturbed in the range of pH 6.15–8.25 of the sea water, while both the time of coagulation and the coagulant power of the blood are strongly inhibited out of this range.

8) Blackish brown fluid is obtained by the autolysis of the hepato-pancreas of *Ligia exotica*. The specific gravity of the hepato-pancreatic fluid is 1.0871 at 18°C, the freezing point is −8.42°C, the value of pH after perfect autolysis is determined as 4.18 potentiometrically by using the hydrogen ion meter with antimon electrode. Hydrolysis with dilute mineral acids destroys the anti-coagulant action, while with alkali no prevention occurs.

9) ·The anti-coagulant power of the fluid is of the order of 1 to 100, while 1 to 400 for retarding the time of coagulation. The hepato-pancreatic fluid is effective also in vivo as in vitro. The anti-coagulant action of the fluid is effective on the common shore crabs and reciprocally the blood of *Ligia* is coagulable by the extract of their hepato-pancreas, while the fact is not seen on the Japanese giant crab. The anti-coagulant action of the fluid on the blood of fishes and the blood incoagulability of *Ligia* caused by their liver extract is quite vague. The anti-coagulant action of the hepato-pancreatic fluid is not destroyed by prolonged boiling, while 1/10 fluid is affected more or less by temperature above 55°C. An hour's cooling at −15°C does not disturb the anti-coagulant action.

10) The coagulant action of one to four drops of M/12 $CaCl_2$ introduced into four drops of the blood is wholly suppressed by the anti-coagulant action of one drop of 1/50 hepato-pancreatic fluid. The degree of the anti-coagulant action of heparin and hirudin for the blood of *Ligia* is of the order of 1 to 400, while that for human blood is of the order of 1 to 100000.

11) Microscopical observation has shown that an explosive cell of Tait is never formed in the incoagulable blood of *Ligia* by the addition of the hepato-pancreatic fluid. December 10, 1937

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Abstracts

303. A Cytological Study on the Maturation and Fertilization of the Egg of *Hynobius retardatus* (An Urodelan Amphibian). Sajiro MAKINO. [Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. VI, 3 (1934), 117–167, 29 figs., 4 pls.] — I. Maturation. In the egg taken from the ovary at the breeding season, the germinal vesicle has occupied a position about a midway on a radius through the animal pole. When the egg is about to leave the ovary, it has located close to the periphery of the egg. The disintegration of the germinal vesicle is initiated by breaking down of its border which causes the outflow of the contents. The chromatin threads in the vesicle is now converted into bivalent chromosomes and move nearer to the egg periphery in preparation for the 1st polar division. The first polar spindle is formed when the eggs are still at the upper part of the oviduct and during their passage down the middle part of the oviduct the course of the division is advanced. The first polocyte is found in a shallow depression on the surface of the egg, having an oval outline 0.042–0.050 mm in diameter when fresh. The second polar spindle appears when the egg reaches the lower part of the oviduct and advances as far as the metaphase. In this condition the eggs pass down to the end part of the oviduct where they stay until spawning takes place. The haploid number of chromosomes is 20 in the polar divisions. II. Fertilization. About 1 to 1 $^1/_2$ hours after insemination the second division is completed. 2 or more hours after the entry of a spermatozoon, the female pronucleus is found metamorphosed at the periphery of the egg. Then it begins to travel back towards the centre increasing in size considerably. On the other hand, the entire spermatozoon enters the egg as early as 15 minutes after insemination. The male pronucleus is found already metamorphosed within 1 hour after the penetration. The conjugation of the two pronuclei occurs during 5 to 6 hours after insemination. The position in which two pronuclei meet, is eccentric towards the animal pole; they meet at the distance of about 1/4 to 1/3 of the egg diameter from the upper pole along the egg-axis through the second polocyte and the centre of the egg. At the time of conjugation male and female pronuclei are quite similar in their structure and size, 0.038–0.042 mm in diameter. After they come in contact they do not actually fuse, but lie side by side in close contact but separated by the nuclear membrane. The paternal and maternal nuclear elements remain in distinct groups during the preparatory stages for the first cleavage division and the chromosomes are found independently in the respective nuclear vesicles. The first cleavage spindle usually appears about 7 hours after insemination. Author.

304. A Comparative Study of the Chromosomes in the Indian Dragonflies. J. J. ASANA and S. MAKINO. [Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. VI, 4, No. 2 (1935), 67–86, 10 figs., 2 tabs.] — The numerical and morphological relations of chromosomes were studied in 10 species of dragonflies from Western India. The studied species are as follows: Fam. Libellulidae — *Pantala flavescens, Tramea limbata, Trithemis pallidinervis, Diplacodes trivialis, Brachythemis contaminata, Crocothemis servilia, Potamarcha obscura* and *Orthetrum sabina;* Fam. Aeschnidae — *Ictinus rapax;* Fam. Coenagrionidae — *Ceriagrion rubiae.* All the members of the Libellulidae show a constancy in number of chromosomes, 25 in diploid and 13 in haploid. In *Ictinus rapax* (Aeschnidae), the diploid is 23 and the haploid 12. In *Ceriagrion rubiae* (Coenagrionidae), 27 in diploid and 14 in haploid. In all species studied there is always present an unpaired X-chromosome which shows post-heterokinesis. In Libellulidae, on the whole, the X-chromosome seems to be of almost uniform size in every species, being nearly equal in magnitude next above the smallest autosome in the spermatogonial complex. In *Ictinus* the X-chromosome is represented by the largest element in the complex. In *Ceriagrion*, the condition of the X-chromosome resembles that of the same element in the members of Libellulidae. The smallest chromosome, the so-called m-chromosome, is present without exception in all species above mentioned. It varies in magnitude from species to species. The varying magnitude of this element relative to the size of the X-chromosome in each species is given in a table. Authors.

305. The Chromosomes of the Edible Crab, *Paralithodes camtschatica* (Tilesius). Hidejiro NIIYAMA. [Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. VI, 4, No. 2 (1935), 59–65, 3 figs.] — The spermatogonium contains 208 chromosomes which range in length from rod to dot, showing gradual diminution in size. The haploid number of chromosomes is determined to be 104 in both of the primary and secondary spermatocytes. Throughout the meiotic phases the author could not identified the heterochromosome by its particular form and behavior. Recent studies on the heterochromosomes in some decapods are shortly discussed. Author.

306. The Chromosomes of a Japanese Spiny Lobster, *Panulirus japonicus* (de Haan). Hidejiro NIIYAMA. [Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. VI, **5**, No. 1 (1936), 21–28, 12 figs., 1 tab.] — In the spermatogonial metaphase the diploid complement consists of 140 chromosomes of which 12 are atelomitic V-shaped elements, while the remaining ones are all telomitic rods showing gradual diminution of size. The atelomitic chromosomes have nearly submedian attachment of the spindle fibres and constitute 6 homologous pairs. The present species is the first representative of the decapods known to have the polymorphic nature of chromosomes. The primary spermatocyte contains, in the metaphase, 70 tetrads, of which some larger ones are compound ringtetrads derived from the atelomitic V-shaped chromosomes. The all tetrads separate into equal halves and there are found no special chromosomes which are particular in shape and behavior. The secondary spermatocyte metaphase shows 70 dyads, showing a complete half set of the spermatogonial chromosomes. The author's suggestion based upon his own findings and the data hitherto obtained from various species of the decapods by many other authors is that fragmentation and association of chromosomes may play an important rôle for variations of the chromosome number in the decapod crustacean species. S. Ichikawa.

307. Studies on the Sex and Chromosomes of the Oriental Human Blood Fluke, *Schistosomum japonicum* Katsurada. Kahei IKEDA and S. MAKINO. [Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. VI, **5** (1936), 57–71, 16 figs., 3 tabs.] — The chromosome complex in both sexes of *Schistosomum japonicum* consists of 16 chromosomes, of which 2 pairs are atelomitic V-shaped and the remaining 6 pairs are telomitic rod-shaped showing intergrading size. Any special chromosomes, acceptable for XY or XX were not absolutely discernible in both sexes of this dioecious trematode. No sexual differences were detected between the male and female cercariae. In this connection a more complete understanding would be expected from the evidences of infection experiments which showed that mammals invaded by cercariae from a single snail usually yield worms of one sex and that neither male nor female worm living under the unisexual infection within the final host becomes mature. The discussion is also about the cause of the predominance of the unisexual parasitism in the intermediate host, *Onchomelania nosophora*.
S. Ichikawa.

308. The Spiral Structure of Chromosomes in the Meiotic Divisions of *Podisma* (Orthoptera). Sajiro MAKINO. [Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. VI, **5**, No. 1 (1936), 29–40, 4 figs., 1 pl.] — The spiral structure of chromosomes was studied in the meiotic chromosomes of the grasshoppers, *Podisma sapporoense* and *P. mikado* (Acridiidae), with smear preparations applying the fixative to the slide. The chromonemata appear as deeply stained and coiled threads which are optically differentiated from the matrical substance within the chromosomes. The chromosomes of the first division seemed to be of double-coiled structure. Evidence is presented that each chromatid forming the meiotic chromosome contains 2 chromonema spirals; hence 4 chromonemata exist in a dyad and 8 in a tetrad. The structural features of chromosomes was compared with that discovered in some plants. Author.

309. Zur Ichneumonidenfauna von Tosa (II). Subfam. Cryptinae. Toichi UCHIDA. [Ins. Mats., **11**, No. 1 & 2 (1936), 1–20, 4 figs.] — Beschreibungen von 31 Arten und 5 Formen; darunter 4 Gattungen, 12 Arten und eine Form für die Wissenschaft neu sind. Neue Gattungen: *Nippocryptus* [Typus — *Hemiteles suzukii* Matsumura], *Caenocryptoides* [Typus — *Ischnojoppa tarsalis* Matsumura], *Paragambrus* [Typus — *Gambrus sapporonis* Uchida], und *Chasmocryptus* [Typus — *Plectocryptus hokkaidensis* Uchida]. Neue Arten: *Goniocryptus tosaensis*, *Habrocryptus shikokuensis*, *Hoplocryptus sugiharai*, *Hygrocryptus wadai*, *Mesostenus* (*Mesostenus*) *discoidalis*, *Hemiteles* (*Aenoplex*) *fukuiyamensis*, *Hemiteles* (*Itamus*) *okamotoi*, *Gelis susakiensis*, *Giraudia spinosa*, *Microcryptus tosaensis*, *Stylocryptus* (*Stylocryptus*) *sugiharai*, und *Phygadeuon kochiensis*. Neue Form: *Endrus flavofasciatus* f. *nigrinotum*. S. Kuwayama.

310. The Chromosomes of Six Species of Ant-lions (Neuroptera). J. J. ASANA and Hisao KICHIJO. [Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. VI, 5 (1936), 121-136, 6 figs.] — The number of chromosomes and the type of sex-chromosomes are studied in the male germ cells of 6 species of ant-lions from India.

Species	Haploid	Diploid	Sex-chromosome
(a) Myrmeleonidae			
1. *Myrmecaelurus* sp. (*M. acerbus*?)	7	14	XY
2. *Macronemurus* sp.?	8	16	XY
3. *Neuroleon* sp.	8	16	XY
4. *Myrmeleon* (*M. sagax*?)	7	14	XY
(b) Ascalaphidae			
5. *Ogcogaster segmentator*	—	22	XY
6. *Glyptobasis dentifera*	—	22	XY

Authors.

311. Beitrag zur Kenntnis der Fungivoriden-Fauna Japans. II: Diadocidiinae (Dipt.). Ichiji OKADA. [Ins. Mats., 11, No. 1 & 2 (1936), 21-24, 1 fig.] — Beschreibung von *Diadocidia ferruginosa* f. *thoracica* n. S. Kuwayama.

312. Beitrag zur Kenntnis der Fungivoriden-Fauna Japans. III: Ditomyiinae (Dipt.). Ichiji OKADA. [Ins. Mats., 11, No. 1 & 2 (1936), 56-60.] — Eine Art, *Symmerus antennalis*, für die wissenschaftliche Welt neu ist und die 2 anderen, *Symmerus annulatus* und *Ditomyia macroptera*, aus unserem faunistischen Gebiet noch nicht beschrieben worden sind. S. Kuwayama.

313. A New and Four Unrecorded Species of Phaoniinae (Dipt., Muscidae) from Japan. Shizuo KATO. [Ins. Mats., 11, No. 1 & 2 (1936), 24-27, 3 figs.] — A new species is described under the name *Trichopticus michitanii*. S. Kuwayama.

314. Die Cerambyciden aus den Kurilen (Col.) (Achter Beitrag zur Kenntnis der Käferfauna der Kurilen). Hiromichi KÔNO. [Ins. Mats., 11, No. 1 & 2 (1936), 28-35.] — Notizen über 28 Arten. S. Kuwayama.

315. Beitrag zu den *Pytho*-Arten Japans (Col.). Hiromichi KÔNO. [Ins. Mats., 11, No. 1 & 2 (1936), 35-37.] — Notizen über 3 Arten, von denen eine Art, *Pytho jezoensis*, für die Wissenschaft neu ist. S. Kuwayama.

316. A New *Cicada*-species from Honshu. Shonen MATSUMURA. [Ins. Mats., 11, No. 1 & 2 (1936), 38.] — Description of *Cicada hooshiana*. S. Kuwayama.

317. Erster Nachtrag zur Ichneumonidenfauna der Kurilen (Subfam. Cryptinae und Pimplinae). Toichi UCHIDA. [Ins. Mats., 11, No. 1 & 2 (1936), 39-55.] — Notizen über 26 Arten und 2 Formen der Cryptinen und 18 Arten und 3 Formen der Pimplinen, von denen 9 Arten und 2 Formen für wissenschaftliche Welt neu sind. Neue Arten: *Cryptus kônoi*, *Cecidonomus sugiharai*, *Hemiteles* (*Hemiteles*) *shanaensis*, *Hemiteles* (*Opisthostenus*) *etorofuensis*, *Gelis shikotanensis*, *Plectocryptus albitarsis*, *Microcryptus maruyamensis*, *Phygadeuon kurilensis* und *Ephialtes nonmanifestator*. Neue Formen: *Habrocryptus assimilis* f. *yezoensis* und *Polysphinctopsis eximia* f. *nigrithorax*. S. Kuwayama.

318. New *Caccobius*-species in Japan with a Tabular Key. Shonen MATSUMURA. [Ins. Mats., 11, No. 1 & 2 (1936), 61-66.] — 13 species of *Caccobius* are found in Japan, 8 of which are new to science. New species: *C. hirayamai*, *C. jonomis*, *C. kasuganus*, *C. narashinensis*, *C. sapporoensis*, *C. suzukii*, *C. yubariensis* and *C. yamauchii*. S. Kuwayama.

319. Fauna of the Thysanoptera in Japan (Part. VII). Masato ISHIDA. [Ins. Mats., 11, No. 1 & 2 (1936), 67-74, 3 figs.] — Original descriptions of *Thrips physapus* f. *brunnea*, *Taeniothrips saussureae* and *Thrips fuscicornis*. S. Kuwayama.

320. Eine neue *Chermes*-Art (Adelgiden) auf Hokkaido. Motonori INOUYE. [Ins. Mats., **11**, No. 1 & 2 (1936), 75–80, 3 figs.] — Beschreibung von *Chermes ishiharai* sp. nov. Die Fundatrix dieser Art findet man wie bei *Ch. japonicus* im Frühjahre (Mitte April) an der Basis der Winterknospe von Fichtenzweigen (*Picea canadaensis*) sitzend, dicht in weisser Wolle eingehüllt. Nach dreimaliger Häutung wird sie zur Stammutter. Die Stammutter beginnt auf parthenogenetischem Wege Eier abzulegen. Die Zahl von den Stammutter abgelegten Eier kann etwa 235 bis 685 Stücke betragen. Nach etwa 10 Tagen entkriechen aus diesen Eiern Junglarven, die zwischen die sich bildenden Gallenschuppen (in die Kammern) zur gelangen suchen. Die entstehende Galle ist kurz, rund und klein (Länge 12 bis 17 mm, Breite 9 bis 13 mm). Im Juli oder schon im Juni springt die Galle auf und entlässt die mit Flügelstummeln versehenen Nymphen, die sich nochmals häuten und zu geflügelten Individuen werden. Diese geflügelten Läuse verbleiben zum Teil auf dem gleichen Baum, auf dem sie entstanden sind, zum Teil fliegen sie auf andere Fichten (*Picea sitchensis*) über. Sofort beginnen die geflügelten Läuse mit der Ablage von etwa 12 bis 34 Eiern, die sie an den Fichtennadeln absetzen und über denen sie absterben. Die daraus nach etwa 10 Tagen ausschlupfenden Junglarven saugen nur kurze Zeit an den Nadeln und wandern dann auf die Winterknospe, am hier im ersten Larvenstadium den Winter zu verbringen. S. Kuwayama.

321. Die von Herrn O. Piel gesammelten chinesischen Ichneumonidenarten. Toichi UCHIDA. [Ins. Mats., **11**, No. 3 (1937), 81–95, 8 figs.] — Beschreibungen von 22 Arten und 6 Formen; darunter 9 Arten, 4 Formen und 2 Gattungen für die Wissenschaft neu sind. Neue Gattungen: *Neoheresiarches* [Typus — *N. albipilosus*] und *Pielia* [Typus — *P. concava*]. Neue Arten: *Protichneumon pieli*, *P. flavitrochanterus*, *Metopichneumon chinensis*, *Coelichneumon pieli*, *Neoheresiarches albipilosus*, *Eupalamus longisuperomediae*, *E. sinensis*, *Pielia concava* und *Melanichneumon* (*Bystra*) *kulingensis*. Neue Formen: *Amblyjoppa japonica* f. *kulingensis*, *Protichneumon moiwanus* f *maxima*, *Coelichneumon bilineatus* f. *sinicus* und *Melanichneumon* (*Bystra*) *albipictus* f. *sinicus*. S. Kuwayama.

322. Die Malacodermen aus den Kurilen. II (Neunter Beitrag zur Kenntnis der Käferfauna der Kurilen). Hiromichi KÔNO. [Ins. Mats., **11**, No. 3 (1937), 96–98.] — Notizen über 5 Arten der Lyciden, 1 Art der Lampyriden, 5 Arten der Cantharidcn, 1 Art der Dasytiden und 1 Art der Cleriden. S. Kuwayama.

323. Eine neue *Epilachna*-Art. Hiromichi KÔNO. [Ins. Mats., **11**, No. 3 (1937), 99, 1 fig.] — Beschreibung von *E. pustulosa* n. sp. S. Kuwayama.

324. On New and Two Unrecorded Species of Aphididae from Japan. Motonori INOUYE. [Ins. Mats., **11**, No. 3 (1937), 100–105, 1 fig.] — Description of *Cinara nopporoensis* parasitic on *Picea Glehni* and records of *C. vanduzei* Swain parasitic on *P. jezoensis*, *P. excelsa* and *P. canadensis* and *Lachniella costata* Zetterstedt parasitic on *P. canadensis*. S. Kuwayama.

325. A Preliminary Revision of Genus *Spinaria* Brullé (Hymen., Braconidae). Chihisa WATANABE. [Ins. Mats., **11**, No. 3 (1937), 106–117, 1 fig.] - Based on the coloration of the wings and abdomen, 13 species and 4 varieties of the genus *Spinaria* are arranged in four groups. S. Kuwayama.

326. Zwei Fungivoriden von der Insel Uruppu in den Mittel Kurilen. Ichiji OKADA. [Ins. Mats., **11**, No. 3 (1937), 118–120, 1 fig.] — Notizen über *Allocotocera pulchella* (Curtis) und *Neurotelia nemoralis* (Meigen). S. Kuwayama.

327. Two New Species of *Caccobius* (Scarabaeidae). Shonen MATSUMURA. [Ins. Mats., **11**, No. 3 (1937), 120–121.] — *C. matsuoi* and *C. amagisanus*. S. Kuwayama.

328. Three New and One Unrecorded Species of Odonata from Korea. Teiichi OKUMURA. [Ins. Mats., **11**, No. 3 (1937), 122–128, 4 pls., 2 figs.] — Descriptions of *Ophiogomphus forficula* n. sp., *Gomphus emarginatus* n. sp., *Gomphus coreanus* (Doi et Okumura) n. sp. and *Davidius lunatus* Bartenef. S. Kuwayama.

329. Die von H. Hori auf der Ins. Meshima gesammelten Curculioniden. Hiromichi KÔNO. [Ins. Mats., **11**, No. 3 (1937), 129-130.] — Beschreibungen von *Orochlesis meshimensis* n. sp., *Rhynchaenus horii* n. sp. und *Apion* (*Squamapion*) *griseopubescens* Roelofs.
S. Kuwayama.

330. An Observation on the Behaviour of the Adult of *Lema oryzae* under the Eclipse of the Sun. (Preliminary report). Satoru KUWAYAMA. [Jour. Sapporo Soc. Agr. & Forest., **28**, No. 135 (1937), 428.] — The activity of the adult of the rice leaf-beetle, *Lema oryzae*, was very much decreased in the course of the eclipse showing the similar condition of activity to that in the evening (about in 6.30 p. m.) except the mating activity. Author.

331. On *Margaronia* (*Glyphodes*) *nigropunctalis* Brem., a Serious Pest to Ash (*Fraxinus mandschurica*) in Hokkaido. Motonori INOUYE. [Jour. Hokkaido Forest Soc., **35**, No. 408, (1936), 539-542.] — The Pyralid, *Margaronia nigropunctalis*, occurred abundantly in the summer of 1936, causing a considerable damage on the foliage of ash. In Hokkaido, it produces two generations each year and the adults emerge in June and September to October.
S. Kuwayama.

332. A Modification of the Harington and Van Slyke Extraction Chamber. (Blood Gas Studies Performed with a New Micro-Blood-Gas-Apparatus. I.) Koichiro SAITO [Jour. Biochem., **25**, No. 1 (1937), 79–87.] — A modified form of the extraction chamber of Harington and Van Slyke is described, which is applicable to 0.1 cc of the sample. The analytical results demonstrate satisfactory accuracy, the probable error found in the blood gas analysis being 0.83% for CO_2 and 1.49% for O_2. Y. Kimura.

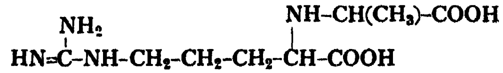
333. Sur la Teneur en Cholestérine des Ongle de quelques Animaux. Kazuo HOTTA et Kenzo TAKAGI. [Jour. Biochem., **25**, No. 1 (1937), 109-111.] - The content of cholesterol of the claw is various according to kinds of animals. Generally speaking, however, it is higher in mammals than in birds. Y. Kimura.

334. Studies on Lipase. III. Report. Effect of Ovarian Follicular Hormone on the Pancreatic Lipase. Yoshio IWASAKI. [Jour. Biochem., **25**, No. 2 (1937), 177-179.] - A demonstration in vitro of an intimate relationship between fat metabolism and the sex hormone. The commercial "ovahormone" preparation promotes the synthetic reaction and retards the hydrolytic reaction of pancreatic lipase. Y. Kimura.

335. The Effect of Ultraviolet- and Röntgen-Rays on the Redox-Potential of the Frog Muscle in Vivo. Yukimaro UCHIMURA. [Jour. Biochem., **25**, No. 2 (1937), 207-217.] — An optimal dosage of irradiation causes the rise of the reduction potential in vivo and in vitro as well. The effect appears promptly after the irradiation in the case of ultraviolet-rays but it appears gradually in the case of Röntgen-rays. These results obtained potentiometrically can also be confirmed chemically, that is, the content of reduced glutathion is found to be increased in the tissue irradiated. Y. Kimura.

336. Untersuchung der Krötengalle. VI. Konstitution der Trioxy-isosterocholensäure. Tayei SHIMURA und Taro KAZUNO. [Jour. Biochem., **25**, No. 2 (1937), 245-249.]
Y. Kimura.

337. Studien über die Konstitution des Octopins, eines stickstoffhaltigen Körpers in den Octopodenmuskeln. Syûzo ASAKI. **I. Mitteilung: Eigenschaften und Abbau des Octopins.** [Jour. Biochem., **25**, No. 2 (1937), 261-280.] **II. Mitteilung: Synthetische Versuche.** [Ebenda, 281-290.] **III. Mitteilung: Stereochemische Untersuchung mittels der Drehkurvenmethode nach Lutz.** [Ebenda, 291-298.] — I) Aus der analytische Befunde wurde das Octopin eine dem Guanidinderivat zugehörende Dicarbonsäure zu sein geschlossen, II) und weiter durch den synthetischen Versuch, bei dem das d-Arginin und das dl-α-Brompropionsäure als Ausgangsmaterial verwandt wurde, wurde die Strukturformel des Octopins klargestellt wie folgt:



$$HN{=}\overset{\overset{NH_2}{|}}{C}-NH-CH_2-CH_2-CH_2-\overset{\overset{NH-CH(CH_3)-COOH}{|}}{C}H-COOH$$

d-Guanido-butyl-äthylamin-α,α′-Dicarbonsäure

Hierauf ist das Octopin als eine Iminodicarbonsäure zu betrachten, welche man in der belebten Natur erst, und zwar zunächst bei Octopus festgestellt hat. III) Die stereochemische Untersuchung eines Isomers des Octopins, der aus dem Reaktionsgemisch von d-Arginin und d-α-Brompropiensäure isoliert werden konnte, ist angegeben. Y. Kimura.

338. Studies on Bog Lakes I. Bog Lake at Tokotan. (Japanese.) Yoshine HADA. [Jap. Jour. Limnol., 6 (1936), 143–151; 7 (1937), 13–30.] — A small brown water lakes (150 m × 47 m, depth 3.5 m) near the east end of Hokkaidô was surveyed nine times in 1934–1935. It is surrounded by the growths of *Sphagnum*, *Menyanthes trifoliata* and *Equisetum polustre*. The transparency of the water ranged between 1.15–1.70 m and it depended upon the amount of zooplankton, especially Rotatoria. The maximum water temperature in summer reached 22.2°C and the surface was frozen in the winter months. The water was in most cases acid and the oxygen in the deep water disappeared in summer. The zooplankton was much more abundant than the phytoplankton. A rotifer *Keratella quadrata* was the dominant species of the summer plankton and it occurred in the deoxygenated strata too. There were also many other anaerobic ciliata. D. Miyadi.

339. Cladocera of Lake Tôhutu of the Island of Kunasiri (S. Kuriles). (Japanese.) Kenzo KONDO. [Jap. Jour. Limnol., 6 (1936), 152–154, 1 pl.] — Besides two species of Cladocera having hitherto been known from this lake two more species are recorded here, viz. *Daphnia cucullata* (G. O. Sars) and *Diaphanosoma brachyurum* (Liévin), the former of which has been known from Hokkaidô too. D. Miyadi.

340. Biological Investigation of Inland Waters of Sikoku, Especially of Tokusima Prefecture. I. Potamoplankton of the Yosino River (I). (Japanese.) Syuiti MORI. [Jap. Jour. Limnol., 6 (1936), 155–162.] — The potamoplankton of the fresh water area of the Yosino-gawa, the longest river (236 km) in Sikoku Island, is composed chiefly of diatoms while the zooplanktens are rare, and most of them are supplied by ponds and lakes connected with the river or from the river bottom. The regional differences in the quality and quantity of plankton are small. D. Miyadi.

341. Changes of External Form after the Metamorphosis of Japanese Lampreys. (Japanese.) Shun OKADA. [Jap. Jour. Limnol., 7 (1937), 1–8.] — The metamorphosis of some lampreys was pursued by rearing them, and the following points were made clear. *Lampetra planeri* (Bloch) lacks the secondary sexual characters and its dorsal fins are separate until about a month before the metamorphosis. In the full grown lamprey the teeth exhibit degeneration and the body length diminishes by 2–3 cm. *Lampetra fluviatilis minor* Kudo et Asada is based on a young specimen of *L. fluviatilis*. *Lampetra mitsukurii* Hatta also seem to be identical with *L. fluvialtilis*. D. Miyadi.

342. Ecological Investigation of a Freshwater Shrimp, *Leander paucidens* (de Haan) in Lake Towada. (Japanese.) Isao MATSUI and Teiitiro WAINAI. [Jap. Jour. Limnol., 7 (1937), 31–44.] — This common shrimp is found abundantly everywhere in the shallow water zone of Lake Towada in northern Japan. It becomes rare below the depth of 30 m, though found at 60 m too. No definite relationship was recognized between the population density of the shrimp and the bottom nature or the vegetation. The male shrimp is smaller in size than the female, and the former is found more numerously on deeper bottom. The number of eggs brooded by the shrimp increases directly proportional to the body length.
D. Miyadi.

343. General Features of some Formosan Lakes in Winter. (Japanese.) Denzaburo MIYADI. [Jap. Jour. Limnol., 7 (1937), 55–63.] — The water was in circulation at about 18.8–21.8°C in January, 1937, and the temperature of the deposits was 0.5–1.0°C higher than that of

the bottom water. The bottom fauna in most of the lakes was very poor in winter as in other seasons. Ryûran-tan near the south end of the island has alkaline water and was very rich in molluscs (*Melanoides scabra* and *M. obliquegranosa*) as well as their empty shells.
D. Miyadi.

344. A Contribution to the Study of the Inland Waters of Kwantung. (Japanese.) Masatake YAMASAKI. [Jap. Jour. Limnol., 7 (1937), 78–84.] — Four water reservoirs in Kwantung were studied for the water temperature, pH, oxygen content and plankton. They are eutrophic and the prodigious development of water bloom chiefly of *Clathrocystis aeruginosa* was seen in three of them. Of zooplanktons, *Ploesoma truncatum, Bosminopsis deitersi, Asplanchna priodonta, Trichocera cylindrica, Diaphanosoma brachyurum* and *Filinia longiseta limnetica* were the dominant species.
D. Miyadi.

345. *Petalocotyle nipponica*, a New Type of the Trematode Family Allocreadiidae. Yoshimasa OZAKI. [Proc. Imp. Acad., **10**, No. 2 (1934), 111–114, 2 figs.] — Description of a new genus and a new species of Trematode, which is remarkable in shape, having a large acetabulum projected prominently from the venter, and bearing at its margin petal-like appendages. The presence of a lymph canal system is also remarkable.
K. Inoue.

346. Occurrence of *Priapulus caudatus* in Northern Japan. Shiro OKUDA. [Proc. Imp. Acad., **10**, No. 2 (1934), 115–116, 3 figs.] — Description on the specimen found in the vicinity of Akkeshi Marine Biological Station. Species belonging to this genus are very rare in Japan.
K. Inoue.

347. Notes on the Early Development of a Stalked Medusa. Kin-ichiro HANAOKA. [Proc. Imp. Acad., **10**, No. 2 (1934), 117–120, 8 figs.] — Observation on *Thaumatoscyphus distinctus*. The sperm is very small, having a triangular head piece and a long tail of about 70–80 μ. Diameter of the egg is about 50 μ. First cleavage occurs two or three hours after fertilization. When 16–32 blastomeres are formed, endoderm formation by unipolar proliferation begins to occur. The gastrula then becomes elongated and in 30–40 hours a planula is formed. The planula, having no segmentation cavity and no cilia on the ectoderm, can creep somewhat in the manner of earthworm.
K. Inoue.

348. Kalzium im Blut des Regenwurms. Kiyoshi AOKI. [Proc. Imp. Acad., **10**, No. 2 (1934), 121–124, 3 Tab.] — Ca-Gehalt im Blut von *Pheretima hilgendorfi* (Mchlen.) wurde durch die veränderten Krammer-Tisdallschen Methode nach B. Groak oder durch dieselben von F. F. Tisdall verbesserten Methode bestimmt. Der Mittelwert beträgt 32.9 mg per 100 gr Blut. Dieser Wert wird gesteigert, wenn CO_2-Gehalt der Atmungsluft zunimmt. Nach dem Verfasser ist es wahrscheinlich, dass diese Erhöhung des Kalks im Blut von den Kalkdrüsen abhängt, aber nicht endgültig.
K. Inoue.

349. Über *Molstyela*, eine merkwürdige neue Gattung von einfachen Ascidien. Asajiro OKA. [Proc. Imp. Acad., **10**, No. 5 (1934), 222-294, 1 fig.] — Beschreibung von *Molstyela izuana* nov. gen., nov. sp. Es ist merkwürdig dass diese Gattung in der inneren Organisation eine echte *Styela* ist, äusserlich aber die Merkmale einer typischen *Molgula* aufweist.
K. Inoue.

350. Male-female Superposition of the Sea-star *Archaster typicus* Müll. et Trosch. Hiroshi OHSHIMA and Hayato IKEDA. [Proc. Imp. Acad., **10**, No. 2 (1934), 125-128, 1 fig.] — Ecological observation of the behaviour of the tropical sea-star.
K. Inoue.

351. Sexual Size-dimorphism in the Sea-star *Archaster typicus* Müll. et Trosch. Hiroshi OHSHIMA and Hayato IKEDA. [Proc. Imp. Acad., **10**, No. 3 (1934), 180-183, 2 figs.] — Biometrical study of the ray-length which is meant for the distance from the center of the mouth opening to the tip of the arm. The mean value of males, as measured in 222 individuals was 55.47±0.194 mm and that of females, as measured in 189 individuals was 59.02±0.288 mm. The ratio of the ray-lengths for each of the 171 pairs of male-female superposition was distributed from 68 to 124, where the ray-length of the female in each pair was taken as 100. The mean value of these ratios was 94±0.006.
K. Inoue.

352. A New Subterranean Copepod from Japan. Masuzo UÉNO. [Proc. Imp. Acad., 10, No. 4 (1934), 229-232, 1 fig., 1 tab.] — Description on *Eucyclops nagasaki* sp. nov.
K. Inoue.

353. Pharmakologische Untersuchungen über „Senso", eine chemische Droge aus abgetrockneten Hautsekret der Kröte. Yoshito KOBAYASHI. [Proc. Imp. Acad., 10, No. 2 (1934), 129-132, 5 Textabb., 1 Tab.] **II. Mitteilung. Eingehende Analyse der Wirkung des ψ-Bufotalin und des ψ-Bufotalinbromides auf die Kalt- und Warmblüterherzen.**
K. Inoue.

354. An Experimental Study of the Compensatory Hemopoiesis in Urodelan Embryos. Atsuhiko ICHIKAWA. [Proc. Imp. Acad., 10, No. 5 (1934), 240-243, 1 fig.] — The author cultured the embryo of *Hynobius retardatus* at gastrula-stage in a high oxygen milieu for 10 to 20 days. By this treatment he could achieve, eliminating any possible injury to the organism, to suppress the development of the primary red corpuscles, the cells of the ventral blood island, before they enter into the circulation. It was ascertained that in such anemic embryo, the endcardial or myocardial cells became the chief source of the compensatory hemopoiesis.
K. Inoue.

355. Comparaison des *Limnatis granulosa* provenant de la Formose et de la Martinique. Asajiro OKA. [Proc. Imp. Acad., 10, No. 5 (1934), 286-288, 1 fig.] — Les *Limnatis granulosa* de la Formose et de la Martinique offerent dans leur coloration des différences assez définies, pour qu'il soit possible de les distinguer au premier coup d'oeil, tout en conservant les caractères morphologiques externes de l'espèce.
Auteur.

356. A New Athecate Hydroid from Misaki. Masao IWATA. [Proc. Imp. Acad., 10, No. 5 (1934), 289-291, 1 fig.] — Description on *Stylactella misakiensis* n. sp. K. Inoue.

357. An Experiment on the So-called Interaction between Transplanted and Normal Limbs. Hiroshi TAKAYA. [Proc. Imp. Acad., 10, No. 5 (1934), 295-298, 2 figs.] — A limb disc was grafted in dorso-dorsal orientation to the limb forming territory of the host. The graft was situated dorsal, ventral, anterior or posterior position with respect to the normal limb disc of the host. Each rudiment developed invariably and produced a few days later two limb-buds parallel. The establishment of the symmetry relationship between the transplanted and the normal limb was limited to those cases where two limbs fused together in the internal cartilagenous structure. On the other hand, superficial fusion of two limbs in their soft parts as well as separated development of them did not cause any change in the imparted parallel direction. From these experimental results, we can not support the hypothesis of "Symmetriefaktor" of Wilhelmi.
K. Inoue.

358. Über das Vorkommen von *Styela partita* im Japan. Asajiro OKA. [Proc. Imp. Acad., 10, No. 3 (1932), 184-186, 1 fig.] — Eine Art von *Styela*, die an der Küste von Yokohama ziemlich häufig vorkommt, wurde geschrieben, und sie wurde vom Verfasser mit der oben genannten Art identifiziert.
K. Inoue.

359. Some Characteristics of *Soboliphyme* sp., a New Nematode from *Martes zibellina sahaliensis* Ognev. Kyojiro SHIMAKURA. [Proc. Imp. Acad., 10, No. 3 (1934), 187-190, 2 figs.]

360. Membrane Potential of the Muscle as a Determining Factor of Excitability. Seiichi OKABE. **Part I. Influence of chlorides on membrane potential and on excitability of the frog's sartorius muscle.** [Jap. Jour. Med. Sci., III, Biophys., 3, No. 1 (1935), 1-15, 10 tabs.] **Part II. Action of hypertonic Ringer's fluid on Membrane potential and on excitability of sartorius muscle of the frog.** [Jap. Jour. Med. Sci., III, Biophys., 3, No. 1 (1935), 17-23, 2 tabs.] **Part III. Action of carbon dioxide on the frog's sartorius muscle.** [Jap. Jour. Med. Sci., III, Biophys., 3, No. 1 (1935), 25-34, 2 figs., 3 tabs.] **Part IV. Effect of fatigue due to prolonged stimulation on the frog's sartorius muscle.** [Jap. Jour. Med. Sci., III, Biophys., 3, No. 1 (1935), 35-40, 1 tab.] **Part V. Effect of glucose**

-Ringer's fluid and extremely hypertonic Ringer's fluid on the frog's sartorius muscle. [Jap. Jour. Med. Sci., III, Biophys., **3**, No. 1 (1935), 41-44, 2 tabs.] **Part VI. Action of calcium chloride on the frog's sartorius muscle.** [Jap. Jour. Med. Sci., III, Biophys., **3**, No. 1 (1935), 45-48, 1 tab.] **Part VII. Action of NaSCN on the frog's sartorius muscle.** [Jap. Jour. Med. Sci., III, Biophys., **3**, No. 1 (1935), 49-53, 1 fig., 1 tab.] — An attempt was made to find the relation, if exist, of the surface polarization (the membrane potential) of the muscle cell to the excitability of it. Half of the muscle was placed under the action of the various solution and the other half was kept under normal condition. The potential difference between the two parts was measured. The threshold voltage of the condenser discharge for the minimal contraction of the muscle was then determined. The excitability of the muscle was represented numerically by the threshold voltage. The experimental results were as follows. KCl, $MgCl_2$, $BaCl_2$ or $SrCl_2$ were added to normal Ringer's solution in the concentration of 10^{-5} mol or 10^{-4} mol. When these chloride Ringer's solutions were applied to the one half of the muscle, both membrane potential and excitability were increased, but when the solution was concentrated more than 10^{-2} mol, the membrane potential was decreased, and also the complete loss of the excitability (KCl) or considerable fall of it (the other 3 chlorides) occurred. By the application of hypertonic Ringer's solution also both membrane potential and excitability were diminished. In the presence of carbon dioxide, the excitability and membrane potential were lowered. Complete recovery of the change could be attained after soaking with Ringer's fluid. By prolonged stimulation injury potential fell profoundly. Glucose-Ringer's solution or $CaCl_2$-Ringer's solution ($4.3 \times 10^{-3} - 1.7 \times 10^{-2}$ mol) also lowered both injury potential and excitability. NaSCN (10^{-2} mol in Ringer's solution) increased the membrane potential and excitability. The author discussed from the experimental data the parallelism between the membrane potential and excitability.

K. Inoue.

361. The Genetics of *Drosophila virilis*. (Continued.) Mitsushige CHINO. [Jap. Jour. Genetics, **12**, No. 5 (1936), 257-277, 5 pls.] — The mutants belonging to the six chromosomes discovered and located mostly by the author are described and illustrated. T. Komai.

362. Genetical Studies of the Lady-bird Beetle, *Harmonia axyridis* Pallas (Report II). Yasusi HOSINO. [Jap. Jour. Genetics, **12**, No. 6 (1936), 307-319.] — The results of the experimental breeding of the lady beetle with a highly variable elytral pattern. The pattern may be classified into 6 types: s (*succinea*), A (*aulica*), S (*spectabilis*), AS, C (*conspicua*) and AC types. The factors for s, A, S and C types are autosomal and constitute a quadruple allelic series; s is largely recessive to any other factor, AS type is the hybrid between A and S AC that between A and C, while S is a simple recessive to C. The presence or absence of a transverse ridge on the elytra is also inherited on the monohybrid basis. T. Komai.

363. Inert regions in the Autosomes of *Drosophila virilis*. Sukeiti FUJII. [Jap. Jour. Genetics, **13**, No. 1 (1937), 1-3.] — In a reciprocal translocation between III and V chromosomes, the ratio in the length of the chromosomes affected by the translocation, shows a great difference between the metaphase and salivary figures. However, if the length of the inert regions are taken into calculation, this disagreement vanishes. The inert regions of those chromosomes are apparently about half as long as the whole chromosomes. T. Komai.

364. Abnormal Inheritance of the Bobbed Character of *Drosophila ananassae*. (A Preliminary Note.) Daigorô MORIWAKI. [Jap. Jour. Genetics, **13**, No. 1 (1937), 4.] — A peculiar inheritance of the Bobbed factor located in the Y chromosome is reported.

T. Komai.

365. A High Frequency Non-disjunction in *Drosophila virilis*. (A Preliminary Note.) Mitsushige CHINO. [Jap. Jour. Genetics, **13**, No. 1 (1937), 5.] — A strain showing ca. 5.8% secondary non-disjunction of the X-chromosome is reported. The corresponding amount in the ordinary strain is only 0.5% on the average. T. Komai.

366. The Composition of the Sex Chromosomes in the Genus *Drosophila*. (A Preliminary Note.) Hisao KATAYAMA and Hideo KIKKAWA. [Jap. Jour. Genetics, **13**, No. 1

(1937), 6-8.] — Several species have similar large V-shaped X-chromosomes in the metaphase plate. Examination of salivary chromosomes reveals 3 types among them in the constitution of the X-chromosome, because of the distinctive staining reaction between the active and inert regions. The first type is rod-shaped, the second small V and the third large V. For comparison of chromosome complexes of different species, this distinction of the two regions is always to be taken into account. T. Komai.

367. The Problem of the Sex-chromosome in the Decapod Crustacea, with Special Reference to the X-Y-chromosomes Found in *Plagusia dentipes* de Haan. (A Preliminary Note.) Hidejiro NIIYAMA. [Jap. Jour. Genetics, **13**, No. 1 (1937), 37-41.] — In the metaphase of the primary spermatocyte, are found 2 peculiar chromosomes of different size, situated above and below the equatorial plate. These are probably X-Y chromosomes. T. Komai.

368. Are Artificial Mutations Caused Directly only? (A Preliminary Note.) Yoshimaro TANAKA. [Jap. Jour. Genetics, **13**, No. 1 (1937), 51-53.] — In a strain of silk-worm treated with X-rays, appeared a dominant mutation 10 generations after the treatment. This case throws doubt on the idea that the effect of radiation is always direct and simple, alleged by certain authors. T. Komai.

369. Genetics of *Drosophila virilis*. (Continued.) Mitsushige CHINO. [Jap. Jour. Genetics, **13**, No. 2 (1937), 100-120.] — Homologous genes of *D. virilis* and *D. melanogaster* are compared. No case is found where homologous genes are found in an autosome in one species and in the X-chromosome in the other. Various types of chromosome aberrations — non-disjunction, translocation, inversion — are much rarer than in *D. melanogaster*. Recessive mutants involved in various wild stocks are mentioned. T. Komai.

370. A Study on the Development of Pigments in Various Eye Color Mutants of *Drosophila*. Kwanji MORI. [Jap. Jour. Genetics, **13**, No. 2 (1937), 81-99.] — The eye color pigments may be classified into reddish and yellowish. As to their distribution in an ommatidium, primary, secondary and basal pigments can be distinguished. Various mutations in eye-color result from modifications either in distribution, quality, quantity, or in the rate of development of the pigments. The mutant genes act always as inhibitors (except in the case of the change in quality). Five sets of "parallel" mutations in eye-color found between *D. melanogaster* and *D. virilis* were tested from the above view-points. Of these three have been proved to be really "parallel" in the mode of development of pigments, but two belong to questionable cases. In respect to quantity, distribution, or in the time of the first appearance of the pigments, the individuals which are homozygous for two eye-color mutant genes, show only the part which is free from the action of either gene. In consequence of combination of two genes, a "white eye" is sometimes produced. This is mainly due to the cumulative action of the combened time modifications of the two genes. In respect to the quality of reddish pigments, heterostatic relations may be perceived. Author.

371. Supplementary Notes on the Blephaloceridae of Japan. Siro KITAKAMI. [Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, **12**, No. 2 (1937), Art. 5, 115-136, 3 pls.] — 6 species are enumerated, of which 3 from Formosa are new. In some of these species all the imago, pupa and larva are described, while in the rest only the larva is described. T. Komai.

372. On the Physiology of the Peritoneal Melanophores of the Frog Tadpole. Kôkichi YAMAMOTO. [Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, **12**, No. 2 (1937), Art. 8, 175-186, I pl.] — There are 3 kinds of melanophores in the tadpole of *Rana rugosa*: the epidermal, the dermal and the peritoneal. These melanophores show some differences in their form, distribution and also in the movement of the granules within them, and these are the changes to be described as the contraction and expansion. The peritoneal melanophores respond by contraction and expansion to the decrease and increase of light respectively. The reaction to the photic stimuli coincides with that of the peritoneal melanophores of the fish *Acheilognathus*, but not with the dermal ones of the latter whose two kinds of melanophores are different in behavior. By narcotising the tadpole, all kinds of melanophores are forced to expand considerably. The peritoneal melanophores are good material for demonstrating the ionic action of the halogenic anions. The effect of alkaloids is ambiguous. The humoral effects of hormones are variable. Adrenalin does not seem to be effective while pituitrin can keep all kinds of melanophores in an expanded state. The peritoneal melanophores react to the change of osmotic pressure, and in this it is much more sensitive than the others. To change of temperature the peritoneal melanophores are less sensitive than the other two. T. Komai.

373. Studies on the Intestinal Protozoa of Termites. III. The Distribution of Glycogen in the Bodies of Intestinal Flagellates of Termites, *Leucotermes* (*Reticulitermes*) *speratus* and *Coptotermes formosanus*. Masatake YAMASAKI. [Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, **12**, No. 2 (1937), Art. 10, 211–224.] — The distribution of reserve glycogen deposits in 14 forms of flagellates found in the two species of termites was determined. The glycogen particles are distributed in definite correlation with the structural differentiation of the endoplasm. They are localized in the parts belonging to the nucleus, the motor apparatus and the remaining endoplasmic parts. This distribution of the glycogen granules seems to have some physiological significance. Especially those in the part adjacent to the motor apparatus are apparently the energy source of the flagellar movement, while those in the other endoplasmic parts seem to be reserve material. T. Komai.

374. Studies on the Intestinal Protozoa of Termites. IV. Glycogen in the body of *Trichonympha agilis* var. *japonica* under Experimental Conditions. Masatake YAMASAKI. [Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B. **12**, No. 2 (1937), Art. 11, 225–235.] — The mode of the change in the distribution of glycogen granules under experimental conditions, namely, starvation, incubation, oxygenation in low temperature and abrupt rise of temperature, has been determined. By these experiments it has been revealed that the anterior part of the body is probably the main region of consumption and the posterior part the region of supply of this material. This throws light on the problem of defaunation of the intestinal protozoa by means of oxygenation. T. Komai.

375. On the Locomotion Types of Certain Japanese Gastropods. Fumihiro HAYASHI. [Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, **12**, No. 2 (1937), Art. 12, 237–251.] — The locomotion types in more than 20 terrestial and marine gastropods were observed and classified. They may be classified primarily into rhythmic, arhythmic, leech-like and leaping, and the rhythmic and arhythmic types may be subdivided further. The neuromuscular mechanism concerned with the locomotion is discussed. T. Komai.

Abstracts

376. Experiments on the Amphibian Mesectoderm, with Special Reference to the Cartilage-Formation. Mamori ICHIKAWA [Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, **12**, No. **3** (1937), 311–351.] — The present investigation, which was carried out in *Rana japonica*, concerns the prospective fates of the mesectoderm, with special reference to its cartilage formation. 1) The mesectoderm begins to migrate in mass downwards in an early neurula-stage and extends considerably before the closure of the neural folds; it does not incorporate in the formation of the neural tube as is the case of urodeles. 2) The migration of the mesectoderm is accomplished simply by the proliferation of its own cells and does not receive contributions from the dorsal portion of the neural tube as in urodeles. 3) Ventrally descending over the mesentoderm, the mesectoderm surrounds each visceral arch and assembles beneath the mesentoderm to give rise to the formation of the mesenchyme *in situ*, some of which enters into the gill. Further, some part of the mesectoderm located ventrolaterally to the neural tube is involved in the formation of the cranial ganglia. 4) The mesectoderm transplanted into the brain-cavity directly produces cartilage. The mesectoderm transplanted into the body side (somatic mesentoderm) proliferates in general and produces large pieces of cartilage in the neighbourhood of the myotomes and notochord. The mesectoderm implanted into the ectodermal tissues yields no positive result for the formation of cartilage, in spite of its ganglionic and mesenchymal differentiation. However, in such cases if the transplant is accompanied with the underlying mesentoderm, cartilage always differentiates. 5) The mesectoderm of the frog transplanted into *Hynobius nebulosus* can develop into the cartilage, if it is placed in the mesenchyme. The mesentoderm, regardless of the generic difference, is important, though not absolute, as in the case of the brain cavity, for the cartilaginous differentiation of the mesectoderm. 6) The mesectoderm is determined in the late stage of gastrulation to produce cartilage, and when the neural folds close together it is completely individualized into each group, mandibular, hyoid and branchial. Extirpation of any group results in lack or deficiency of the corresponding cartilage. As the result of extirpation the cartilages such as supra- and infrarostral, Meckel's cartilage, palatoquadrate and anterior trabecular bar are found to be derived from the mandibular group, hyoid and the first basibranchium from the hyoid group, and all the branchial cartilages are produced from the branchial groups. Among the last named cartilages, the first is only derived from the anterior group, while the rest from the posterior group of the branchial mesectoderm. 7) The basibranchium is of double origin; the large proximal portion which is produced by the union of the hyoid groups on both sides, and the small distal portion which is derived from the mesentoderm in front of the heart. The double nature of the cartilage is proved by the extirpation of all the mesectodermal elements from both sides of the head, with the resulting formation of the mesentodermal second basibranchium alone. 8) The auditory capsule is derived from the cranial mesentoderm and not from the mesectoderm. The fact is well established in both extirpation as well as transplantation experiments. 9) The hypobranchial plate is chiefly produced from the first branchial cartilage but partly also from the second branchial. If the development of the first is checked, the second substitutes for it.
Author.

377. Combination of Two Limb-rudiments in Urodele *Triturus*, with Special Reference to Their Symmetry Relations. Hirosi TAKAYA. [Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, **12**, No. **3**, (1937), 353–383.] — To investigate the mutual action between two limbs establishing an enantiomorphism, two limb rudiments were combined in the embryo of *Triturus pyrrhogaster* (Boie). Combination was made 1) by transplanting an additional rudiment in one of these positions, anterior, posterior, dorsal and ventral in close contact with the normal limb disc, or 2) by grafting two rudiments at the same time in a heterotopic position, the axial relation being varied in each position with respect to the *ap* and *dv* axes. Thus, in the first case the axial relation between two limbs, and in the second the relation of the combined limbs to the body axis were [illegible]mined. 1) There occurred generally in compatibility in the growth between two combined rudiments. In the antero-posterior combination the posterior member, whether it belonged to the host or to the graft, always proceeded the development of the anterior member. In the dorso-ventral combination, it was the ventral member which generally checked the development. 2) Even when two limbs developed, fusion was very frequent between them and in some cases resulted in a reversal of the prospective asymmetry in one member. The reversal of asymmetry was found to be brought about generally in the direction from harmonic to disharmonic with respect to the body side, with the resulting production of an enantiomorphism. This phenomenon was actually found in the following series of operations: a) In the *hom aa dd* transplantation in the posterior position, reversal of asymmetry took place on the side of the regular limb of the host, resulting in the production of a radial mirror image. b) In the *hom aa dd* and *het aa dv* transplantations in the antetior position, the asymmetry of the transplanted limb was reversed and mirroring in the radial plane occurred. c) In the *hom aa dd* transplantation in the ventral position, the palmar image was produced by reversing the dorsiventrality of the grafted limb. 3) In the heterotopic transplantation, two rudiments combined in the same axial direction as in (a) and (b) of the second section resulting similarly in the occurence of a radial mirror image even when their *ap* axis was inverted with regard to that of the body. 4) In the combination placing the *ap* axis of the rudiments in an antagonistic direction, reversal of the prospective asymmetry did not occur, irrespective of the fusion between them. Reduplication and anomaly, which were often met with in one or both members of the combined limbs, usually interrupted them to realize the given symmetrical arrangement, though in a few cases a figure like a radial or ulnar mirror image was actually produced according to the relative position of one rudiment with respect to the other. 5) From these facts, it appears that an interaction really exists between two combined limbs. However, the action, so far as their enantiomorphism is concerned seems to work on one side and is not reciprocal between them. That is to say, its effect is noticed only in the particular member which varies according to the different combinations. This phenomenon should be attributed to the qualitative difference within the limb disc, and the action is, therefore, to be defined as a sectional conflict and not necessarily extended to the whole limb disc. Author.

378. Studies on Cirripedian Fauna of Japan. II. Cirripeds found in the Vicinity of the Seto Marine Biological Laboratory. Fujio HIRO. [Mem. Coll. Sci., Kyoto Imp. Univ. Ser. B, **12**, No. **3** (1937), 385–478.] — 72 species of 'thoracic' cirripeds collected and identified by the author are described with many illustrations, including *Balanus granulatus* n. sp. and *Octolasmis Weberi pennatulae* n. subsp. and also 9 species named previously by him.
T. Komai.

379. Bopyrids from Tanabe Bay. IV. Sueo M. SHIINO. [Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, **12**, No. **3** (1937), 479–493.] — Descriptions with figures of: *Pseudione longicanda* n. sp., *Procepon insolitum* n. gen. and n. sp., *Portunicepon tiariniae* n. sp. and *Anomopharyxus deformatus* n. gen. and n. sp. T. Komai.

380. The Chromosomes of an Earwig, *Forficula scudderi* Borm. A. B. MISRA. [Jap. Jour. Genetics, **13**, Nos. **3–4** (1987). 171–176.] — The spermatogonial chromosomes are 24, including an XY pair. The primary spermatocyte shows 12 bivalent chromosomes of which one is an XY set. All secondary spermatocytes have 12 chromosomes, and are distinguished into two kinds containing an X chromosome and a Y chromosome respectively. Thus *Fortificula scudderi* differs in its sex chromosome type from *F. auricularia* which has XX–Y type sex-Chromosomes.
T. Komai.

381. A Note on the Chromosomes of *Acrydium japonicum* (Orthoptera. A. B. MISRA. [Jap. Jour. Genetics, **13**, Nos. **3–4** (1937), 175–176.] — In the spermatogonial metaphase there are 13 chromosomes — 6 pairs of autosomes plus an X-chromosome which is easily recognizable on account of its rough contour. The autosomes exhibit a great range of size variation among themselves. The primary spermatocytes contain 7 rod-shaped tetrads in various stages of separation. The X is usually eccentric in position and goes undivided to one pole. Thus two kinds of secondary spermatocytes are produced, containing 7 and 6 chromosomes respectively. The chromosomes are all V-shaped being composed of two rods superimposed one upon the other.

These observations remind one of the cases of other *Acrydium* species reported by Robertson.
T. Komai.

382. On the Chromosomes of the Two Species of Insectivora (A Preliminary Note). Shinkichi TATEISHI. [Jap. Jour. Genetics, **13**, No. 5 (1937), 212.] — In *Crocidura (Pachyura) murina*, the gemini found in the first spermatocytic division are 20 in number. The chromosomes in the second division number 20, while the spermatogonial chromosomes are 40. The sex chromosomes are represented by a large geminus situated in the peripheral region of the first spermatocytic plate. This geminus consists of a comparatively large crooked X and a much smaller J-like Z, both having an atelomitic spindle fiber attachment. In the metaphase a part of the chromatid between X and Y is open into a ring. In *Mogera insularis* there appear 16 gemini in the first spermotocytic division, including an X-Y type sex-chromosome set. The X is a rod bent in a right angle with an arm placed on the plate and the other arm parallel to the spindle axis, while the Y is a short spindle-shaped body lying parallel to the spindle axis.
T. Komai.

383. Studies on Certain Enhancers of Crossing-over in *Drosophila ananassae* (A Preliminary Note). Daigoro MORIWAKI. [Jap. Journ. Genetics, **13**, No. 5 (1937), 232-233.] — By the presence of the Minute-II b gene in the male, 2.8 percent crossingovers occur in that sex. The same gene enhances the crossingover in the female also. The effect of the gene is strongest on the regions directly adjacent to its locus. T. Komai.

384. Abnormal Staining Capacity of the Sixth Salivary Gland Chromosome found in Certain Strains of *Drosophila virilis* (A Preliminary Note). Sukeichi FUJII. [Jap. Jour. Genetics, **13**, No. 5 (1937), 234-236.] — There are two different types among the wild strains of this fly with respect to the staining capacity of the sixth chromosome. In Type 1 represented by the New Orleans strain the chromosome shows a pronouncedly weaker staining capacity than in Type 2 to which all Japanese strains belong. In the hybrid between the two types the two sixth chromosomes derived from different strains lie side by side without fusing completely together. An experiment with *Gap, glossy* stock has revealed that while the Japanese strains produce 0.1+crossingover between *Gap* and *glossy*, the New Orleans strain does not. The *Gap hump* lethal 6a strain derived from an American wild strain has also weakly stained sixth chromosomes, while all the 24 Japanese and Korean and one Chinese wild strains examined belong to Type 2. The number and arrangement of the individual bands in the chromosomes of the two types are identical. T. Komai.

385. A Terminal Inversion found in *Drosopila ananassae* (A Preliminary Note). Hideo KIKKAWA [Jap. Jour. Genetics, **13**, No. 5 (1937), 237-239.] — From several wild strains collected from various localities of North America, China and Japan, 5 inversions and 3 cases of superfluous chromatin have been detected. Of the inversions C III L reported first by Kaufmann in 1936 has been found in 10 out of 16 strains examined. This inversion is noteworthy first in being terminal and second in occurring in several wild strains from widely separated localities.
T. Komai.

386. On Chromosomes of some Chelonians (A Preliminary Note). Kenji NAKAMURA. [Jap. Jour. Genetics, **13**, No. 5 (1937), 240.] — In *Clemmys mutica, Geomyda spengleri, Cyclemys flavomarginata* the chromosome numbers are: $2n=52$, $n=26$. The chromosomes are much like those of *Clemmys japonica* previously reported, there being 4 large V's and 2 long rods. Examination of the chromosome sets of the embryo and young directly after hatching of *Caretta olivacea*, have revealed: $2n=58$ (spermatogonial), or 57 (ovogonial). In this species also 4 large V's and 2 long rods may be clearly distinguished. T. Komai.

387. Time of Stimulation and Mosaicism (A Preliminary Note). Yoshimaro TANAKA and J. C. YOUNG. [Jap. Jour. Genetics, **13**, No. 5 (1937). 243-244.] — From the silkworm eggs subjected to centrifuging in high (35°,C) or low (0°-1°C) temperature, at the stage when the embryonic body is largely laid out, 6 mosaic worms were obtained. These, except one, belonged to the bilateral type or its modifications, contrary to the recognized fact that such mosaicism is due to disturbances in an early developmental stage. This observation may be accounted for by the assumptions: 1. the first cleavage of the egg determines the future bilateral plane of the worm; 2. the subsequent cleavage may be slightly different in tempo in the two bilateral halves of the future body; 3. the susceptability to stimulus may be somewhat different according to the phase of the nuclear division, so that, 4. the part of the body which contains the nucleus that was affected by the stimulus will show eventually an abnormal feature, while the other part that contains the unchanged nucleus exhibits a normal feature. T. Komai.

388. On the Management of Coniferous Forest with the View of their Protection against *Ips japonicus* Niisima. Shimonji TABATA. [Rept. Saghalien Centr. Exp. Sta., No. **14,** (1936), 1-152] — *Ips japonicus* is one of the injurious insects widely found in the coniferous forests in southern Saghalien. In twelve years it has devastated 179, 959 hectars of forest; though its destructive power seems to be on the wane, it has not yet been quite exterminated. This beetle devors *Picea jezoensis* Carr., *P. glehnii* Masters and *Larix dahurica* Turcz., and especially when it finds weak or withered trees of the first species. This beetle has normally one generation a year, passing the winter in adult stage under the bark of food trees. The overwintering adult enters into activity under 5°-6°C, crawls out under 16.5°C, and begins to fly under 20°C, the fly height in forest being 6-7 m, often 20-30 m or more. Oviposition period extends 16 days, depositing 52 eggs, and incubation period varies 3 to 12 days among the eggs deposited by one female. Larval stage lasts 17 to 28 days and about 3 weeks on an average, and the pupal 4 to 10 days and normally 8-10 days. Thus, 44 to 80 days, or 70 days on an average, are needed for the completion of stages from egg-deposition to the adult. As predators to this beetle, *Thanasimus karafutonis* Kôno, *Xantholinus* sp., *Medetera* sp., *Chelifer* sp. ?, and *Monotarsobius holstii* Pocock ?, and as parasites *Coeloides* sp., *Ipocoelius* sp., *Pteromalus* sp. and *Trichogramma* sp. are enumarated. Thirteen birds belonging to *Dorycopus*, *Doryobates*, *Picoides*, *Regulus*, *Parus*, *Aegithalos*, *Certhia* and *Sitta* are also considered to play a rôle in the control of this pest. S. Kuwayama.

389. Insect-fauna of Saghalien. Pt. I. Butterflies (Lepidoptera-Rhopalocera). Matuzi HORI and Koiti TAMANUKI. [Rept. Saghalien Centr. Exp. Sta., No. **19,** (1937), 1-224, 8 pls.] — The present report is the result of investigation on the butterflies occurring in the island of Saghalien, inclusive of both the northern and southern parts, compiling into a historical sketch, notes, on the previous collectors, remarks on the ecological characteristics and the geographical distribution, as well as descriptions of the species, with the keys to the species, genera, and families. The number of species of butterflies occurring in the island amounts so far in all to 72, referable to 33 genera and 6 families, including one revised and 3 unrecorded species and 2 new aberrant forms. Unrecorded species: *Lethe schrenckii* Ménétriés (from Saghalien), *Melitaea athalia orientalis* Ménétriés (subspecies from Japan), and *Argynnis aphirape ossianus* Herbst (from Japan). Revised species: *Lycaena eros erotidis* Staudinger=*L. icarus fuchsi* Sheljuzhko. New aberrant form: *Argynnis adippe satakei* Nakahara ab *toyoharae* and *Zephyrus taxila* Bremer ab. *harukii*. According to the authors' investigation, Saghalien can be divided into three districts so far as the butterflies are concerned: the South-west, the South and the North districts. The South-west district has some affinity with the other two districts on the one hand, however, there are found several species such as *Papilio xuthus*, *Pieris melete*, *Lethe schrenckii* and *Lycaena lycormas* on the other hand, which are not represented in the latter districts but are distributed in Hokkaido and other islands of Japan proper. Occurrence of such species must be due to the warmer climate of the district. The insect-fauna of the North district is most closely allied to that of Amur and northern Siberia (Siberian subregion) lacking the southern elements altogetner. It must be also pointed out that such species as *Anthocaris cardamines kobayashii*, *Coenonympha hero pilwonis*, *Argynnis aphirope ossianus*, *A. selenis sibirica*, *A. selene chibiana*, *A. miyakei*, *A. pales neopales*, *Melitaea athalia sachalinensis*, *M. athalia orientalis*, *Lycaena icarus fuchsi*, *Erynnis comma sachalinensis*, etc. are represented only in this district in Saghalien. The fauna of the South district consists chiefly of the elements of Siberian subregion, however there is also a slight connection with that of the Manchurian subregion. The type species in this district are *Parnassius stubbendorfi*; *Coenonympha hero perseis*, *Argynnis oscarus sachalinensis*, *A. thore karafutonis*, *Pamphila silvius*, *P. palaemon murasei*, etc. *Colias palaeno orientalis* and *Lycaena optilete sibirica* are also distributed in this district, while *Oeneis jutta sachalinensis*, *Argynnis aphirape* *ossianus* and *Everes fischeri* which are quite common in the North district are not distributed. The investigation on the distribution of butterflies in Saghalien and other neighbouring regions proves that the Tugaru Strait (Blakiston's line) appears of less importance than the Soya Strait (Hatta's line) as a boundary line of the Palaearctic fauna in Japan, so far as it concerns the insects, especially butterflies. On the other hand the fauna of insects in the South-west district of Saghalien seems to contain decidedly more elements of Japan proper than in the other districts. This fact leads us to propose a new boundary line somewhere in the northern part of Japan further north than the Soya Strait. This line is running somewhat parallel to the isothermal line in summer. Other new boundary lines in the Kuriles and the opposite continent — Amur and Ussurie districts are also to be drawn. Of these boundary lines those in Saghalien and the Kuriles are altogether liable to be somewhat more southward than both Miyabe's line (Etorofu Strait in the Kuriles) and Schmidt's line (from Due to Shikuka in Saghalien) which were proposed from the phytogeographical point of view. S. Kuwayama.

390. Chafers, or Scarabaeid Beetles, and their Relation to Agriculture. Satoru KUWAYAMA. [Bull. Hokkaido Agr. Exp. Sta., No. **61**, (1937), 1-73, 5 pls. & 33 figs.] General discussions on the Lamellicorns in relation to agriculture in Hokkaido. *Serica orientalis* Motschulsky, *Heptophylla picea* Motschulky, *Popillia japonica* Newman, *Anomala rufocuprea* Motschulsky, *A. geniculata* Motschulsky, *A. testaceipes* Motschulsky and *A. cuprea* Hope are enumerated as more important pests in Hokkaido and described all stages, with notes on their life-histories and instances of the injury they have been observed to cause. *A. rufocuprea*, A. *geniculata* and *P. japonica* attack the foliage of fruit trees, vegetables and other crops in adult stage and also attack the roots of cereals, vegetables and many other crops in larval stage. Adults of *A. testaceipes* feed chiefly on larch, but the larvae are very injurious to the roots of cereals, vegetables, etc. Adults of *H. picea*, of which larvae have been known to injure young spruce trees, occasionally feed on rice, but have not found on other cultivated plants. Injuries done by *S. orientalis* and *A. cuprea* are also restricted in adult stage. *H. picea* and *S. orientalis* complete their life-cycles in a year, whereas the species of *Anomala* and *Popillia* require two or three years for development. Other subterranean insects attacking cultivated plants in Hokkaido are mentioned to be comparable with the Lamellicorns. They include *Bourletiella pruinosa* Tullberg, *Gryllotalpa africana* Parisot de Beauvois, *Agrotis ypsilon* Rottenburg, *A. informis* Leech, *Euxoa segetum* Butler, *Rhyacia c-nigrum* Linné, *Barathra brassicae* Linné, *Chortophila flavopicta* Matsumura, *C. cilicrura* Rondani, *Nephrotoma minuticornis* Alexander, *Agriotes fuscicollis* Miwa, *Corymbites puncticollis* Motschulsky, etc. Natural enemies of the Lamellicorns include various birds, such as *Spodiopsar cineraceus* Temminck and *Sturnia philippensis* Forster, the Tachinid, *Centeter cinerea* Aldrich, and the Asilid, *Promachus yesonicus* Bigot; the descriptions and notes of them are also given. Author.

391. Ein neuer Schmarotzer von *Deudrolimus spectabilis* aus China. Toichi UCHIDA [Ins. Mats., **11**, No. **4**, (1937), 131.] — Beschreibung von *Itoplectis nigribasis*. S. Kuwayama.

392. Some New Butterflies from Japan and Korea. Shonen MATSUMURA. [Ins. Mats., **11**, No. 4 (1937), 132-134, 1 pl.] — Descriptions of *Parnassius everesmani* f. *sasai* n., *P. citrinarius* f. *kyotonis* n., *Anthocaris cardamines* f. *isshikii* (♂), *A. cardamines* f. *kobayashii* (♂) and *A. cardamines* f. *koreana* n. S. Kuwayama.

393. Neue and wenig bekannte Käfer Japans. II. Oedemeridae. Hiromichi KONO. [Ins. Mats., **11**, No. 4 (1937). 135-146, 8 figs.] — Notizen über 17 japanischen und 4 micronesischen Arten, von denen 1 Gattung, 8 Arten, 1 Unterart für die Wissenschaft neue sind. Neue Arten: *Asclera subrugosa*, *Eobia matsumurai*, *Anancosessinia* (n. g.) *tarsalis*, *Schistopselaphus sonani* [Japan], *Eobia uchiyamai*, *E. truckana*, *E. gigantea* und *Allocaris flavipes* [Micronesien]. Neue Untrart: *Eobia chinensis kotoensis*. S. Kuwayama.

394. Einige neue Formen der japanischen Bockkäfer nebst Bemerkungen über Synonym und geographische Verbreitung. M. MATSUSHITA u. K. TAMANUKI. [Ins. Mats., **11**, No. **4** (1937). **146-149**] — Neue Aberrationen: *Leptura variicornis* ab. *anticerufa*, *L. variicornis* ab. *inornata*, *Strangalia vicaria* ab. *fujisana*, *S. vicaria* ab. *asahinai*, und *S. subtilis* ab. *ohishii*. Neue Varietät: *Bumetopia oscitans* var. *kiushuensis*. S. Kuwayama.

395. New *Ontophagus*-species in Japan with a Tabular Key. Shonen MATSUMURA. [Ins. Jap., **11**, No. 4 (1937), 150–169.] — Descriptions of 32 species. New species: *Onthophagus aequiperus* (Mats. et Yohena), *O. akirai*, *O. chibanus* (Mats. et Yohena), *O. chuzenjianus*, *O. hikosanus*, *O. hyuganus* *O. ibonus*, *O. jedensis* (Mats. et Yohena), *O. kandai*, *O. kawarinus*, *O. kogatanus*, *O. komabellus*, *O. kozunomis*, *O. matsuokai* (Mats. et Yohena), *O. minoi* (Mats. et Yohena), *O. misujianus*, *O. miyazakianus*, *O. oishii*, *O. okushirianus*, *O. oniellus*, *O. shigeoi*, *O. shurianus* (Mats. ei Yohena) *O. sobosanus*, *O spurius*, *O. takabayashii*, *O. ushiodai*, *O. yedanus*, *O. yubarinus*, *O yugianus* and *O. yumigatanus*. Newly named species: *O. yohenai* (=*O. shinanensis* f. *brevicornus* Yohena nec Fähraeus). New form; *O. yubarinus* f. *taiheizana*.
S. Kuwayama.

396. Neue und wenig bekannte Käfer Japans. III Gattung *Ixalma*. Hiromichi KÔNO. [Trans. Sapporo Nat. Hist. Soc., **15**, pt. 1 (1937) 29–32, 2 figs.] — Notizen über 5 Arten, von denen 2 Arten, *Ixalma okadai* und *I. nigriventris* für die Wissenschaft neu sind.
S. Kuwayama.

397. Nachtrag zu den Nematoceren von den Kurilen. (Diptera). Ichiji OKADA. [Trans. Sapporo Nat. Hist. Soc., **15**, pt 1, (1937), 33–39, 2 Figs.] — Beschreibungen von 8 Fungivorid- und 2 Bibionid-Arten. Neue Arten: *Megophthalmidia longicornis*. Neue Form: *Apemon similis* f. *nigricoxa*. S. Kuwayama.

398. Peculiarity on the Insect-fauna of the Southern Saghalien. Matuzi HORI. [Report from the Karafuto Office, No. **5** (1937), 148–155.] — Abut 2000 species of insects are known to occur in the southern Saghalien at present. These insect-fauna, especially of butterflies, are in close relation to that of Amur and Ussurie and then to that of the Kuriles and the northern Korea, while the relation to Hokkaido is rather slight. In other words, the insect-fauna of the southern Saghalien consists of Eurasiatic elements. Ecologically, reduction of generations per year, delay in sping emergence, shortness in the duration of diurnal activity, fewness in the seasonal form, richness in alpine insects, fewness in species but many in individual and possibility on frequent appearance of new pests are all peculiarity on the insect-fauna of the southern Saghalien. S. Kuwayama.

399. On *Anobium* (*Ernobius*) *abietis* F. Motonori INOUYE. [Jour. Forest. Soc., **36**, (1937), 414–416, 3 figs.] — Brief notes on the bionomics and extent of injuries, with precautions on the controlling measures. S. Kuwayama.

400. Onthophagid-insects from Korea with Descriptions of New Species. Shonen MATSUMURA. [Ins. Mats., **12**, No. 1, (1937), 1–3] — An enumeration of 20 species, of which 7 are new to science and described. New species: *Onthophagus amenthus*, *O. chosensis*, *O. koma*, *O. micellus*, *O. miyabei*, *O. nakatomii*, and *O. shoyozonus*. S. Kuwayama.

401. Die Lamellicornien aus den Kurilen. II (Zehnter Beitrag zur Kenntnis der Käferfauna der Kurilen). Hiromichi KÔNO. [Ins. Mats., **12**, No. 1 (1937), 6–8] — Notizen über 9 Arten, von denen eine Art, *Aphodius* (*Agrilinus*) *etrofuensis*, für die Wissenschaft neu ist.
S. Kuwayama.

402. Einige Ichneumonidenarten aus Kotosho. Toichi UCHIDA. [Ins. Mats., **12**, No. 1 (1937), 9–12, 1 fig.] — Notizen über 7 Arten. Unter den gezeichneten Arten sind *Epirhyssa kanoi*, *Agrypon sulcosum* und *Xanthopimpla kriegeri* Ashmead f. *yami* für die wissenschaftliche Welt neu. S. Kuwayama.

403. Ibalinae of Nippon (Hym., Cynipidae). Keizo YASUMATSU. [Ins. Mats., **12**, No. 1 (1937), 13–18, 1 pl.] — A list of the species of the Genus *Ibalia* of Nippon, a key to the species, and descriptions of *I. takachihoi* n. sp. and of the male of *I. japonica* Matsumura as well as some comparisons among the species are given. S. Kuwayama.

404. **Beitrag zur Kenntnis der Fungivoriden-Fauna Japans. IV: Macrocerinae (Dipt.)** Ichiji OKADA. [Ins. Mats., **12,** No. 1 (1937), 19-27, 3 figs.] — Notizeu über 6 Arten. Neue Arten: *Macrocera abdominalis, M. alpicoloides* und *M. ezoensis.* S. Kuwayama.

405. **Die Ptilininen Japans (Col.)** Hiromichi KONO et Hun Kyu KIM. [Ins. Mats., **12,** No. 1 (1937), 28-31, 2 figs.] — Notizen über 5 Arten. Neue Arten: *Ptilinus cercidiphylli, P. galloisi* und *P. formosanus.* S. Kuwayama.

406. **New Japanese Ichneumonidae parasitic on the Sawflies.** R. A. CUSHMAN. [Ins. Mats., **12,** No. 1 (1937), 32-38] — Descriptions of 5 new species based on material reared from cocoons of *Diprion nipponicum* Rohwer and *Neodiprion sertifer* Geoffroy; viz., *Pezoporus annulaticrus, P. opacus, Delomerista japonica, Lephyroplectus nipponensis,* and *Lamachus albopictus.*
S. Kuwayama.

407. **On Some Species of Braconidae from Manchoukuo (Contributions to the Knowledge of the Braconid Fauna of Manchoukuo, I)** Chihisa WATANABE. [Ins. Mats., **12,** No. 1 (1937), 39-44, 1 fig.] — Notes and descriptions of 9 species, of which a new one *Apanteles kariyai* is included. S. Kuwayama.

408. **Beitrag zur Kenntnis der Fungivoriden-Fauna Japans. V: Lygistorrhininae (Dipt.)** Ichiji OKADA. [Ins. Mats., **12,** No. 1 (1937), 45-48. 1 fig.] — Beschreibung von *Lygistorrhina pictipennis* sp. nov. S. Kuwayama.

409. **Eine neue *Alcides*-Art aus Korea (Col. Curc.).** Hiromichi KÔNO. [Ins. Mats., **12,** No. 1 (1937), 49, 1 fig.] — Beschreibung von *Alcides saitoi* sp. nov. S. Kuwayama.

410. **Eine neue Unterart der *Bredhos parthenias* Linnaeus aus Japan (Beiträge zur Kenntnis der Systematik der Geometriden Japans. I).** Takahisa SAWAMOTO. [Ins. Mats., **12,** No. 1 (1937), 50-52, 2 figs.] — Beschreibung von *B. parthenias hilara* subsp. nov.
S. Kuwayama.

411. **On One New Species of Earthworm belonging to the Genus *Pheretima* from North-eastern Honshu, Japan.** S. HATAI and S. OHFUCHI. [Saito Ho-on Kwai Mus., Res. Bull., XII (1937), 1-11, 2 figs.] — *Pheretima servinus* is described as new to science. Fine illustrations are given, and described in full are the external charaters, internal characters, and the habitat. S, Ohfuchi.

412. **Descriptions of Three New Species of the Genus *Pheretima* from North-eastern Honshu, Japan.** S. OHFUCHI. [Saito Ho-on Kwai Mus., Res. Bull., XII. (1937), 13-29, 4 figs.] — Three new species, *Pheretima hataii, Ph. gomejimensis* and *P. oyuensis* are described, illustrated and fully dealt with as to internal and external characters. *Pheretima oyuensis* was found to be without spermathecae, male pores, prostatic ducts and prostate gland.
Author.

413. **On the Species Possessing Four Pairs of Spermathecae in the Genus *Pheretima*, Together with the Variability of some External and Internal Characteristics.** S. OHFUCHI. [Saito Ho-on Kwai Mus. Res. Bull., XII (1937), 31-136, 36 figs., and 1 pl.] — The main object of the study was to determine the number of species of *Pheretima* in North-eastern Honshu, which possess four pairs of spermathecae, to study their limits of variation in regard to external and internal characteristics. The study shows that certain revision must be made, especially in external characteristics, such as the variation of the oriffice, the position and the number of genital papillae which are usually located close to the spermathecal openings. Also variation was noticed in regard to the presence or absence on the left or right side only or on both sides of the male pores. Author.

414. Echiuroidea, Sipunculoidea and Priapuloidea obtained in North-east Honshu, Japan. H. Sato. [Saito Ho-on Kwai Mus. Res. Bull. XII (1937), 137–176, 14 figs, and 3 pls] — The following species are dealt with, namely: Urechis unicinctus (von Drasche), *Ikeda taenioides* (Ikeda), *Arhynchite arhynchite* (Ikeda), *Sipunculus nudus* Linnaeus, *Siphonosoma cumanense* (Keferstein), *S. mourense* Sato, *Physocosoma japonicum* (Grube), *P. scilops* (Selenka et de Man), *Phascolosoma vulgare* (de Blainville). *P. zenibakense* Ikeda, *P. catharinae* F. Müller, *P. onagawa* Sato, *P. hozawai* Sato, *Dendrostoma blandum* Selenka et de Man, *D. hexadactylum* Sato, *Phascolion ikedai* Sato, *P. dentalicola* Sato, and *Priapulus bicaudatus* Danielssen. Among these, three are described as new to science, namely, *Phascolosoma onagawa*, *P. hozawai* and *Phascolion dentalicola*. S. Ohfuchi.

415. Notes on the Amphibia of the Tohoku Districts, Northern Japan. Yaichiro Okada. [Saito Ho-on Kwai Mus. Res. Bull., XII (1937), 172–206, 13 figs., and 3 pls.] — The species mentioned in his report are, *Triturus pyrrhogaster* Boie *Hynobius lichenatus* Boulenger, *H. nigrescens* Stejneger, *Onychodactylus japonicus* (Houttuyn), *Bufo vulgaris formosus* Boulenger, *B. vulgaris montanus*, sp. nov., *Hyla arborea japonica* Guenther, *Rana nigromaculata nigromaculata* Hallowell, *R. japonica* Guenther, *R. temporaria ornativentris* Werner, *R. rugos* Schlegel, *Racophorus schlegelii schlegelii* Guenther, *R. schl. arborea* Okada et Kawano, *Polypedates buergeri* (Schlegel). Full descriptions and the localities are given in detail. S. Ohfuchi.

416. Additional Pyramidellidae from Siogama Bay, with Remarks on the Molluscan Fauna, Especially Pyramidellidae from Sagami Bay; being a Comparative Study. Shichiroku NOMURA. [Saito Ho-on Kwai Mus. Res. Bull., XIII, 11–107 (1937). 11 pls.] — As the second contribution to the Pyramidellidae fauna of Siogama Bay, the author makes a comparative study with the fauna of Sagami Bay, adding a list of the molluscan shells from Sagami Bay, and comparing them with that of Siogama Bay. From Siogama bay, the author reports 30 species, which include the following new species, *Odostomia* (Odostomia) *exiguita*, *O.* (*O.*) *kotorana*, *O.* (*O.*) *bentizimana*. *O.* (*O.*) *crassicallosa*, *O.* (*O.*) *jucundio*, *O.* (*O.*) *eronea*, *O.* (*O.*) *asapera*, *O.* (*O.*) *pallidior*, *O.* (*O.*) *perplexissima*, *O.* (*O.*) *sitiroi*, *O.* (*O.*) *tritestata*, *O* (*O.*) *profundiperforata*, *O.* (*O.*) *neoexigua*, *O.* (*O.*) *makiyamai*, *O.* (*O.*) *bullata*, *O.* (*O.*) *tenerissima*, *O.* (*O.*) *dilecta*, *O.* (*Sinuatodostomia*) *sinuosa*, *Menestho* (*Menestho*) *cingulitissima*, *Siogamaia odostomides*, *S. kinkwazan*, *Chrysallida* (*Chrysallida*?) *semipunctata*, *Agatha infrequens*, *Turbonilla* (*Turbonilla*) *eupellucida* and *T.* (*Pyrgiscus*) *bisculpta*. Also one new section Crenatodostomia and one new subgenus *Sinuatodostomia* have been established. In the material from Sagami Bay 56 species are recorded. Among them, the new ones are. *Syrnola* (*Syrnola*) *hasimotoi*, *S.* (*S.*) *azona*, *S.* (*S.*) *zona*, *Odostomia* (*Odostomia*) *sagamiana*, *O.* (*O.*) *vera*, *O.* (*O.*) *dusiensis*, *O.* (*O.*) *kanagawaensis*, *O.* (*O.*) *miuraensis*, *O.* (*Sinuatodostomia*) *watarui*, *Chrysallida* (*Miralda*) *kohei*, *C.* (*M.*) *tempeii*, *C.* (*M.*) *sitizoi*, *Siogamaia quantoensis*, *Cingulina* (*Cingulina*) *biarata*, *Turbonilla* (*Turbonilla*) *hasimotoi*, *T.* (*T.*) *kanagawana*, *T.* (*T.*) *ridiculosa*, *T.* (*T.*) *mollita*, *T.* (*T.*) *mira*, *T.* (*T.*) *cura*, *T.* (*T.*) *mala*, *T.* (*Pyrgiscua*) *valdissima*, *T.* (*P.*) *deae*, *T.* (*P.*) *hataiana*, *T.* (*P.*) *miura*, *T.* (*P.*) *miurana*, *T.* (*P.*) *bona*, *T.* (*P.*) *pseudorex*, *T.* (*Dunkeria*) *dusiana*, and *T.* (*Sulcoturbonilla*) *quantoana*. This report is the second one to the Pyramidellidae fauna of Japan, and is very valuable from various points of view. It includes beautiful illustrations and many descriptions. S. Ohfuchi.

417. On Some Recent Venerid Mollusca from North-east Honsyu, Japan. Shichiroku NOMURA. [Saito Ho-on Kwai Mus. Res. Bull., XIII (1937), 7–10, 1 pl.] — The author deals with the species of the genus *Protothaca*, and finds that for the species *adamsii* Reeve, the new generic name *Protocallithaca* should be proposed. From Hukusima prefecture, he has described one new species, *Procothaca schencki*. From this report, we can now see the general features of the Protothaca-fauna of northern Japan. Fine illustrations and full descriptions added with remarks are given. S. Ohfuchi.

418. On the Variation of *Neptunea arthritica* Bernardi from Northern and Central Honsyu, Japan. Shichiroku NOMURA and K. HATAI. [Saito Ho-on Kwai Mus. Res. Bull., XIII (1937), 1–5, 2 pls.] — This article deals with the variation of the common whelk, *Neptunea arthritica* Bernardi, a species distributed from Central to Northern Honsyu, and showing significant variation according to localities. The environment and variation in regard to localities are described, and the following new forms are recognized, forms *tyosi*, forma *syobuta*, forma *matusima* and forma *asamusi*; and for a fossil form, the name forma *miyata* is proposed. With these forma names proposed, the writers find that each of the forms indicates a particular kind of sculpture, and that by comparing these different kinds of sculptures with the fossil specimens from the Kwantô region of Central Japan, explanations to the past climatological conditions during the deposition of the Pleistocene Narita beds of the Kwantô region may be solved in part. S. Ohfuchi.

419. Foraminifera from Siogama Bay, Miyagi Prefecture, Japan. K. ASANO. [Saito Ho-on Kwai Mus. Res. Bull., XIII (1937), 109–119, 2 pls.] — Altogether 78 species are listed, and among them the new ones are, *Pyrgo siogamensis* and *Eponides orientalis*. Species originally described from fossil materials are also well represented in the recent ones from the Bay, thus giving a rather long geological range to them. S. Ohfuchi.

420. Limnological Researches of Onne-to in the Akan Region (Hokkaido). (Japanese.) Yoshine HADA and Takuo CHIBA. [Jap. Journ. Limnol., 7, No. 3 (1937), 113–120, 3 pls., 2 figs.] — This small volcanic-barrier lake (0.21 sq. km, greatest depth 9.8 m, altitude 610 m) of the seepage type was surveyed twice. It has disharmonic acidotrophic water with pH 5.2. In winter were collected under the ice-cover two kinds of zooplanktons, *Keratella quadrata* and *Arcella vulgaris* and about 10 species of diatoms. In summer following zooplanktons were seen, *Cyclops leuckarti*. *Daphnia longispina hyalina*, *Bosmina coregoni*, *Notommata* sp., *Keratella quadrata* and *K. cochlearis*, but their population was very small and the phytoplanktons were fewer in summer than in winter. No fish was found in the lake because it has no surface drainage.

D. Miyadi.

421. On the Animals of the Yuhuin Hot-spring (North-eastern Kyusyu). (Japanese.) Yuichi ITO. [Jap. Journ. Limnol., 7, No. 4 (1937), 150–157, 8 figs.] — Faunal survey of some carbonate hot-springs near Yuhuin gained the following animals: *Rana japonica*, *Aplocheilus latipes*, *Phoxinus steindachneri*, *Stratiomyia japonica*, *Gerris lacustris*, *Laccobius* sp., *Lycosa pseudoannulata*, *Caridina denticulata*, *Lymnaea japonica*, *Semisulcospira libertina* and *Stenothyra* sp. The temperature and pH of the water in which animals occurred ranged between 34.5 45.8°C and 7.2–8.75 respectively. The most resistant was *Laccobius* sp., which was found in the water of 45.8°C. No animal was seen in the water with temperatures higher than 50°C. While *Rana*, *Laccobius*, *Stratiomyia* and *Lymnaea* are rather common inhabitants of many Japanese hot-springs, *Caridina* and *Stenothyra* are rare examples. D. Miyadi.

422. Biological Investigations of Inland Waters of Sikoku, especially of Tokusima Prefecture. I. Potamoplankton of the Yosino River (2). (Japanese.) Syûiti MORI. [Jap. Journ. Limnol., 7, No. 4 (1937), 158–172, 7 figs.] — The plankton was collected quantitatively by a water bottle in both fresh and brackish water areas of the Yosino River to ascertain its vertical distribution and the influences of tide as well as other environmental factors on it. The Potamoplanktons are more numerous in the deeper layer rather than near the surface, and this is explained by the fact that a considerable portion of them is supplied from the river bottom. In the brackish water area, greater number of planktons are collected in the high water of the tide than in the low but the smallest population occurs a short time after the lowest level of the tide. D. Miyadi.

423. Report on the Sipunculoidea, Echiuroidea and Priapuloidea collected by the Sôyô-Maru Expedition of 1922–1930. H. SATÔ. [Sci. Rep., Tohoku Imp. Univ., Ser. IV, 9, No. 1. (1934), 1–32, 1 pl.] — The author describes the following species and varieties. Sipunculoidea: 1) *Sipunculus nudus* Linnaeus, 2) *Siphonosoma* sp., 3) *Phascolosama vulgare* var. *tropicum* Sluiter, 4) *P. margaritaceum* var. *antarcticum* Michaelsen, 5) *P. appendiculatum*, n. sp., 6) *P. glossipapillosum*, n. sp., 7) *P. hyugense*, n. sp-, 8) *P. noto*, n. sp., 9) *P. signum*, n. sp., 10) *P. soyo*, n. sp.. 11) *Dendrostoma ellipticum*, n. sp. Echiuroidea: 12) *Thalassema* sp. (?). Priapuloidea: 13) *Priapulus bicaudatus* Danielssen. The occurrence of Priapuloidea in Japanese waters was reported for the first time. S. Nomura.

424. On the Mechanism of Fertilization and Development without Membrane Formation in the Sea Urchin Egg, With Notes on a New Method of Artificial Parthenogenesis. Isao MOTOMURA. [Sci. Rep., Tohoku Imp. Univ., Ser. IV (Biol.), 9, No. 1 (1934), 33-45. 10 figs.] — 1) The formation of the fertilization and hyaline membranes was inhibited by previously activating the eggs of the sea urchins. *Strongylocentrotus nudus, S. pulcherrimus* and *Pseudocentrotus depressus* with the solution of butyric acid in sea water. The development without membrane formation thus was caused by the effect of the parthenogenetic activator and that of the sperm combined together. 2) Isotonic, hypertonic and hypotonic urea solutions act as parthenogenetic activators. The egg of *S. pulcherrimus* developed to a gastrula when treated with the isotonic urea solution at first and then with the hypertonic sea water. 3) The butyric acid sea water and urea solution are alike in their activating effect. 4) The hyaline membrane was dissolved in the urea solution, but not in the butyric acid sea water.

S. Nomura.

425. On the Coelomic Corpuscles in the Body Fluid of Some Invertebrates. I. Reaction of the Leucocytes of a Holothuroid, *Caudina chilensis* (J. Müller), to Vital Dyes. Toshio OHUYE. [Sci. Rep., Tôhoku Imp. Univ., Ser. IV, 9, No. 1 (1934), 47-52. 5 figs.] — The reactions of coelomic corpuscles of *Caudina chilensis* to trypan blue and carmine were examined. The white, fusiform, brown and minute corpuscles ingested these dyes abundantly or sparsely, while red and crystal corpuscles ingested none of them. The author classifies the white corpuscles into two groups: the leucocytes and amoebocytes with colorless spherules. The former show active ingestion of vital dyes, while the latter show none or less active ingestion. The coelomic corpuscles tend to agglutinate in the drawn out perivisceral fluid. The cells forming the clotting are chiefly leucocytes. S. Nomura.

426. On the Coelomic Corpuscles in the Body Fluid of Some Invertebrates. II. On the Coelomic Corpuscles of an Earth Worm, *Drawida Hattamimizu*, Hatai. Toshio OHUYE. [Sci. Rep., Tôhoku Imp. Univ., Ser. IV, 9, No. 1 (1934), 53-59. 1 fig. & 2 pls.] - The body fluid of *Drawida hattamimizu* contains five types of leucocytes: the lymphocytes, monocytes, granulocytes, lamprocytes and linocytes. The perivisceral fluid contains detached chloragocytes and peritoneal cells in addition to leucocytes. The lymphocytes, monocytes and peritoneal cells show the positive reaction to the vital staining with trypan blue and carmine. The vital preparation of linocytes contained also granules of trypan blue in rare cases. The eosinophilic granulocytes constitute about 32% of the total leucocyte count, and make the characteristic feature of the blood picture of *Drawida hattamimizu*. The thread-like substance in the linocytes could not be detected. S. Nomura.

427. Contributions to the Physiology of the Ascaris. II. The Respiratory Exchange in the Ascaris, *Ascaris megalocephala* Cloq. Yoshiyuki TORYU. [Sci. Rep., Tôhoku Imp. Univ., Ser. IV, 9, No. 1 (1934), 33-70. 3 figs.] -- *Ascaris megalocephala* is facultatively anaerobiotic. The worm in Ringer's solution containing oxygen consumes oxygen until the oxygen tension in the medium is lowered down to about 0.03% in volume. The worm also produces carbon dioxide in deoxygenated Ringer's solution, though the amount is much less than it produces in the presence of oxygen. The total amount of carbon dioxide produced in 24 hours at 38°C. was from 80 cc (female) to 200 cc (male) per 100 gm of the worm in the presence of oxygen, and from 20 cc (male) to 80 cc (female) in the absence of oxygen. S. Nomura.

428. Experimental Note on the Presence of Electrically Excitable Areas in the Reptilian Cerebral Hemisphere: *Clemmy Japonica*. Hideomi TUGE and Masayasu YAZAKI. [Sci. Rep., Tôhoku Imp. Univ., Ser. IV, 9, No. 1 (1934), 79-85. 4 figs.] — As the electrical excitability of the cerebral hemisphere has not been studied to a satisfactory extent, the authors took up the present experimental work. The cerebral hemisphere was electrically stimulated, and three excitable areas have been found by observing the corresponding responses. The excitable areas A, B and C are indicated in a diagram and transverse sections of these areas illustrate the arrangement of cells in these areas. Stimulation of the areas A and B provoked the movement of the head and the neck; stimulation of the area C caused movement of the jaw (opening of the mouth). S. Nomura.

429. Inductive Effect of Tissues other than Retina on the Presumptive Lens-Epithelium. Yô K. OKADA and Yoshiki MIKAMI. [Proc. Imp. Acad., 13. No. 7 (1937) 283-285, 4 figs.] — Many authors are of opinion that variaus tissues and organs other than eye-cup also have the power to induce the lens-formation. But there has been no complete proof for it. In this paper the authors report on the study of this problem using embryos of *Triturus pyrrhogaster* as the material. The primordial eye-cup was removed from an embryo before the lens-determination and a small piece of tissues or organs to be tested was introduced in its place in order to see whether these substitutes posses the power of the formation of a lens. Here were employed nose anlage, ear vesicle, brain, heart and liver of early embryos, dorsal wall of the archenteron, neural plate, ectoderm, mesoderm and endoderm of the head region. It became clear from these experiments that all the grafts, with the exception of the dorsal lip of the blastopore, had power in inducing the lens-formation. The lenses induced in this way were always differentiated into both epithelia and fibres. K. Inoue.

430. The Conduction Velocity in the Leg-Nerve of the Giant Crab, *Macrocheira kaempferi*. Takeo KAMADA and Haruo KINOSHITA. [Proc. Imp. Acad., 13. No. 6 (1937), 220-222, 1 fig.] — Comparing the latent periods of the contraction of the Dactylopodite, the conduction velocity of the nervous impuls was measured as a usual way. The stimuli applied to the nerve were alternating current of 50 cycles. The measured velocity was 3.9–2.7 m/sec at the temperature of 16°C–12.5°C. This value is not very different from those which have been reported in other marine crabs by Bonge and Rosenberg. It is interesting that the decrement of the velocity was not observed in such long conducting path which sometimes reached to 37 cm.
K. Inoue.

431. Parker's Effect in Melanophore Reactions of *Macropodus opercularis*. Takeo KAMADA. [Proc. Imp. Acad., 13. No. 6. (1937) 217-219 3 figs.] — Parker has shown that when a short transvere cut is made near the root of the caudal fin of *Fundulus*, melanophores quickly expand in the area from the incision to the margin of the tail. Such response was called by the author as the Parker's effect. The author proved experimentally that the anemia caused by the incision is not the primary cause of the Parker's effect. The skin color reaction of this sort relates to the nervous impuls. The author is of the opinion that the melanophore expanding nerve takes their course along the dorsal aorta, and melanophore contracting nerve along the spinal cord. K. Inoue.

432. Means to Kill or Remove Parasitic Dipteran larvae by Their Negative Oscillotropism. Nobumasa YAGI. [Proc. Imp. Acad., 13, No. 5 (1937). 165-168, 8 figs.] — The author succeeded in finding parasites' behavior in responce to either simple mechanical or sonic or supersonic vibrations that may be applied to combat against their damages. If the parasitized fruits exposed in the supersonic vibration, the parsites, larvae of *Drosophila suzukii*, were driven out from the fruits. The action of the vibrations on the *Crossocosmia sericariae*, which is the maggot parasitic in the pupa of silk worm, is the most important from the practical view point. Such parasites in pupae could be killed in 10 minutes from 60–100% simply by the vibrations of tuning fork. K. Inoue.

433. Negative Oscillotropism of *Drosophila* larva to Supersonic Vibrations. Nobumasa YAGI. [Proc. Imp. Acad., 13, No. 5 (1937), 161-164, 3 figs.] — The Action of supersonic vibrations on the behavior of *Drosophila* larva was studied. The author observed the behavior of the animals on vertical and horizontal oscillating plane. It was discovered that the movement of larvae can be expressed by Weber-Fechner's law, that is, the velocity V of movement is proportional to logarithm of the intensity of electric current I through the oscillation bulb.
$V = K \log_{10} I$ K was ca. 0.36. In this way the negative oscillotropism was secured. The receptor of supersonic vibration was supposed to be chordotonal organ. K. Inoue.

434. An Insect Vector of the Dwarf Disease of Rice Plant. Teikichi FUKUSHI. [Proc. Imp. Acad., 13, No. 8 (1937), 328-331, 1 fig.] — For long time it was believed that *Nephotettix apicalis* var. *cincticeps* Uhl. (=*N. bipunctatus cincticeps*) is the sole agent to transmit

the dwarf disease of rice plant. But the author proved that *Deltocephalus dorsalis* Motsch. acts as an another vector of the malady. K. Inoue.

435. The Effect of the Electro-tonus on the Refractory Phase of the Peripheral Nerve. II. (Japanese). Tadazi KAWARADA. [Nihon Seirigaku Zassi, **1**, No. 1 (1936) 1-5, 3 figs.] — When the first stimulus is strong enough to cause " Fick's Interval ", the least interval becomes shorter than the other case. But such shortening occurs only when the first stimulating current retends more than 0.05 mili-seconds. The author explained this phenomenon by the electrotonic effect which was left after the first stimulating current. K. Inoue.

436. Über die Entwicklung des Embryos von *Ascaris lumbricoides* in der Eihülle (Japanisch). Kaoru NAKATA. [Chôsen Igk. Z., **26** (1936), 509-520, 2 Tfln.] — Der Verfasser hat die mit 2%iger Chlorkalklösung behandelten Ascaris-Eier in der Zimmertemperatur oder in 25°C kultiviert, um ihre morphologischen Veränderungen in der Einhülle zu verfolgen. Die wichtigen Resultate lauten etwa folgendermassen: Das Ascaris-Ei wird zuerst in gewisser Zeit nach der Embryobildung übertragbar, und vor dem Übertragbarwerden geht wenigstens einmalige Häutung vorher, die anfangs im Schwanzteil des Embryos angedeutet ist, um schliesslich vor einigen Tagen des Übertragbarwerden im Kopf- und Schwanzteil auffallend zu werden. Als Unterscheidungsmerkmale zwischen den übertragbaren Larven und nicht-übertragbaren sind Verschwinden der Krümmung der Speiseröhren-lumen, Häutung vom Kopf und Schwanz, Entwicklung der Exkretionsorgane, Erscheinen der Seitenlinien oder der Mitellinien am Rucken und Bauch anzugeben. Sh. Suzuki.

437. Über die inneren Geschlechtsorgane der einseitig kastrierten Tiere. (Japanisch). Totarô TANAKA. [Osaka Igk. Z., **35** (1936), 2047-2057] — Der Verfasser hat die Veränderungen der inneren Geschlechtsorganen bei den einseitig kastrierten weiblichen Mäusen untersucht und etwa folgende Resultate bekommen: Bei den kastrierten jungen Tieren vergrössert sich das überbleibende Ovarium 1.7 fach wie das normale, bei den kastrierten Erwachsenen etwa 1.5 fach. Im 1.4 fach vergösserten Ovarium sinkt die Funktion ziemlich herab, während bei den 1.6 fach vergrösserten etwas aufsteigt. Die Körpergewichtszunahme nach der Kastration wird meistens von der Hypertrophie des Ovariums begleitet. Die Ovarialzyste beeinflüsst bis zu einem gewissen Grad der Vergrösserung die Geschlechtsfunktion niemals, oder vielmehr steigernd. Der Uterus wird bei den jungen Tieren nach der einseitgen kastration kürzer und dicker, dagegen beiden Erwachsenen länger und schmaler. Ausserdem zeigt sich der Uterusteil der kastrierten Seite die Abnahme sowohl des Längsdurchmessers wie auch des Gewichts im Vergleich mit dem der Kontrollseite. Sh. Suzuki.

438. Über die Vererbung der künstlich vermehrten Kernzahl bei *Stylonychia mytilus*. (Japanisch). Yonetiyo KAMIYAMA. [Seiri Kenkyû. **13** (1936), 182-189, 7 Textabb.] — Die vorliegenden Untersuchungen sind in der Absicht ausgeführt, die Erbfähigkeit der operativ hervorgerufenen Kernzahlvermehrung klar zu machen. Die Resultate lauten etwa folgendermassen: *Stylonychia mytilus*, eine eigentlich 2 kernhaltige Protozoa, kann durch operativem Eingriff 3 Kerne bekommen, welche sich bis auf zweite Generation vererben können. Und solche Dreikernigkeit vererbt sich bis auf die zweiten Generation, aber auf die dritten nicht mehr. Aber bisweilen kann schon in der ersten Generation die eigentliche Zweikernigkeit auftreten. Das operativ durchgeschnittene kernlose Stück dieses Tieres ist nicht regenerationsfähig, das kernhaltige stehet dagegen ganz im Gegenteil. Der grosse Kern von Protozoa scheint keine Erbmasse in sich haben. Sh. Suzuki.

439. Über das Vitamin A im Fettorgan des Ochsenfrosches (*Rana catesbiana*). (Japanisch). Kiyohiro MATUSAKI. [Seiri Kenkyu, **13** (1936), 639-642, 4 Textabb.] — Um das Vitamin A im Fettorgane vom Ochsenfrosch nachzuweissen, hat der Verfasser 6 Gruppen von Mäusen z. T. mit Fettorgan-Substanz-haltigen Nahrung und z. T. mit ganz von solche Substanz freien gefüttert. Die Resultate sind wie folgt: Im Fettorgan von *Rana catesbiana* wird das Vitamin A gefunden, und in 1.0-1.5 gr der vom Anfang Mai bis zum Anfangs September bekommenen Organsubstanz wird es in der äquivalenten Dosis mit 1.0 gr vom Lebertran behalten. Sh. Suzuki.

440. Vier Arten von Anopheles- Moskitos in Chosen. (Englisch). Manabu YAMADA. (Keijô J. Med. 7 (1936), 191-210, 5 Tab. u. 10 Tafl.] — Seit 1932 konnte Verf. die Entwicklung von 4 Arten Moskitos in Chosen, *Anopheles sinensis, A. koreicus, A. sineroides* und *A. edwardsi* beobachten, indem er von den gefangenen Weibchen gelegten Eier im Laboratorium gezüchtet hatte. Hier hat er die Charakter der Eier, der Larven von IV Stadium und der Puppen eingehend und zwar vergleichend beschrieben. M. Niizima.

441. Die Offenbarung des Glykogens in Protozoa. (Japanisch). Tetsuji KIMURA u. Yoshishige KONNO. [Nihon Byori K., 26 (1936) 415-419, 2 Tab.] -- Mit Best'scher Karmin-Methode haben Verff. das Glykogengehalt der Protozoen wie *Noctiluca, Trypanosoma, Trichomonas, Amoeba, Entamoeba, Gregarina, Sarcocystis, Colpidium, Paramaecium, Spirostomum, Blepharisma, Stylonychia* und *Vorticella* untersucht. Sie enthalten grosse oder mässige Menge von Glykogen mit Ausnahme von *Amoeba proteus, Sarcocystis* und *Noctiluca*. Es gibt keine Beziehung zwischen dem Glykogengehalt der Protozoen und ihrer Lebensweise, d. h. Parasitentum oder freiem Leben. Die Protozoen, die sich anoxybiontisch unterhalten, enthalten nicht besonders grosse Menge von Glykogen. Das Glykogen tritt hauptsächlich in Cytoplasma auf und wenig in Vakuolen. Es offenbart sich diffus rötlich oder als kleine oder mittelgrosse Granula. M. Niizima

442. Über die Bedeutung der Fette in Hinsicht auf Ontogenese und Phylogenese während der Entwickelung des Zentralnervensystems. Kenkichi MORI. [Nihon Byori K., 26 (1936), 544-546] - Vom Standpunkt der Ontogenese und Phylogenese hat Verf, ausser menschlichem Embryo das Hühner- und Kaninchen-embryo zur Untersuchung herangezogen, um das Verhalten der Fette während ihrer Entwicklung und ferner ihre Bedeutung kennen zu lernen. Nach den Resultaten kann man folgendermassen sagen: Das Fett des Zentralnervensystems in der Embryonalzeit wird gerade in dem Stadium, da seine Entwicklung lebhaftesten vor sich geht, sehr reichlich beobachtet, dagegen in der späteren Embryonalzeit, da die Entwicklung des Zentralnervensystems beinahe vollendet ist oder nur noch langsam fortschreitet, bleibt dieses Fett stationär oder vermindert, sogar verschwindet. Deshalb kann man mit Recht annehmen, dass das Fett im fetalen Leben fur die Entwicklung ber Hirnsubstanz eine gewisse Rolle spielt, sodass es um progressiven resp. aufbauenden Sinne betrachtet werden soll. Ferner ist es annehmbar, dass bei Hühner-embryonen, die vom Eidotter ihre Nährstoff aufnehmen und dabei viel Fett als Vorrat im Körper enthalten, mehr Fett in Zentralnervensystem schon in früheren Fetalzeiten haben als Amnioten. M. Niizima.

443. Zur Frage nach der Neubildung von Zellen im tierischen Organismus. 1. Bildung von Zellen und Blutinseln aus Dotterkugeln beim Hühnerembryo. O. B. LEPESCHINSKAJA. [Cytologia 7 (1936), 54-81 m. 5 Textfig., 4 Taf.] — Verf. hat eine Frage gestellt, ob Zellen nur aus Zellen entstehen, und beim Hühnerembryo Untersuchungen über die Entstehung der sog. Zellen aus den Dotterkugeln, die als Nichtzellen betrachtet sind, ausgeführt. Die Methodik der Untersuchungen wurden nach drei Richtungen durchgeführt, nämlich: 1. Gewöhnliche histologische Methode an frühen Entwicklungsstadien. 2. Gewebskultur. 3. Nachprüfung der durch invivo-Beobachtungen an der Kultur erhaltenen Ergebnissen an histologischen Schnitten. Die Ergebnisse sind etwa folgende: Die Dotterkugeln haben viel Gemeinsames mit den Übergangsformen zwischen protoplasmatischen Massen und Zellen. Kugeln, die aus der Dottermasse in die Subembryonalhöhle herausgefallen sind, weisen auf verschiedenen Entwicklungsstadien der Embryonen einen verschiedenen Bau des Kerns auf: „protoplasmatische Kerne“, „Kern mit dem Anfangsstadiem der Lininnetzbildung“, völlig ausgebildeter Kern, Kerne auf verschiedenen Stadien der karyokinetischen Teilung. Die Granula der weissen Dotterkugeln bei der Gewebskultur befinden sich in Brown'scher Bewegung, die zu einer polarisierter wird und auf diesem Wege zur Entstehung des Kerns führt. Der Entstehungsprozess des Kerns fährt über eine Reihe aufeinander folgend. Aus den Dotterkugeln, die in den Hohlraum zwischen den Keimblättern gelangten, entstehen Blutinseln. Verf. ist der Ansicht, dass die Dotterkugeln, welche keine Zellen sind, also zur Lebenstätigkeit, zur formativen Prozessen und selbst zur Umwandlung in Zellen befähigt sind. M. Niizima.

444. Über die Blutbildung und Eisenablagerung in der Milz bei Pflanzenfresser. Toku IWAO u. Masao SATO. [Nihon Byori K., 26 (1936), 317-334. 12 Textfig.] — In der Milz der untersuchten Hüftiere (Pferd, Rind, Schwein und Ziege) sind die blutbildenden Herde in der Umgebung des Lymphfollikels in grosser Häufigkeit vorhanden. Diese Herde sind nicht ausgesprochen in der Milz von dem 14 Tage alten Schwein, und dem Wachstumsgrad des jungen Schweins entsprechend werden die Herde allmählich auffallender. Die Milz wird also zuerst im postfetalen Leben zum blutbildenden Organ. Die Menge des abgeschiedenen Eisens in der Milz ist beim erwachsenen Pferde am grössten und relativ klein am erwachsenen Schwein. Diese Eisenabscheidung scheint zur gefressenen Oxalsäure abhängig zu sein. Dem Fortschreiten des Alters entsprechend nimmt das Eisen an Menge zu. Die Tatsche, dass die Abscheidungsorte des Eisens in der Milz des Pflanzenfresser immer blutarm sind und die grosse Menge Eisens extrazellulär abgeschieden ist, lehrt uns dass einmal in der Milz abgeschiedenes Eisen zu Hämoglobinbildung nicht mehr benutzt wird. In der Milz der Fleischfresser kann man kleine blutbildende Herde erkennen, sie liegen aber nicht in der Umgebung des Lymphfollikels. M. Niizima.

445. Über die Epiphyse bei einigen wasserbewohnenden Säugetieren. Gennosuke FUSE. [Arb. Anat. Inst. Sendai, 18 (1936), 241-341.] — Sehr genaue Beschreibungen über die Epiphysengegend bei *Latax lutris* L., *Phoca vitulina* L., *Phoca hispida largha* Pallas, *Callorninus ursinus* Gray, *Delphinus longirostris* Gray, *Lagenorhynchus obliquidens* Gill, *Balaenoptera borealis* Lessen und *Neomeris phocaenoides* Cuvier. Epiphyse ist bei *Latax*. *Phoca* und *Callorhinus* gut entwickelt, bei *Neomeris* rudimentär erhalten, bei *Delphinus*, *Lagenorhynchus* sowie bei *Balaenoptera* vollständig fehlend. Ausdehnung, Form und Lage der Epiphyse, ihre Höhle, ihre Höhenverhältnisse zum Ganglion habenulae und der Taenia thalami, dann die Struktur sowie dass sub- und suprakommissurale Epithelorgan sind in dieser Arbeit näher berichtet. Mit dem Namen „ Organon supracommissurale " meint Verfasser das besondere Epithel der Epiphysenhöhle, welches sich oberhalb der Commissura posterior vorfindet und strukturell dem subkommissuralen völlig gleicht. Die markhaltigen Nervenfasern, die von der Commissura habenularum und der Commissura intermedia des Epiphysenstiels herkommend in den Randschichten der Epiphyse nach hinten verlaufen, sind auch nach der Tierart in verschiedener Menge, Verteilung und Länge bemerkbar. T. Ogawa.

446. Über eine strukturelle Besonderheit am Kern (oder der Substantia gelatinosa Rolando) der spinalen Quintuswurzel beim Seeotter (*Latax lutris* L.). Yoshimichi SUZUKI. [Arb. Anat. Inst. Sendai, 18 (1936), 235-240, 4 Taf.] — Verfasser bemerkte beim Seeotter eine ungewöhnliche starke Entwicklung der traubenförmigen Zellgruppen im Oblongatasegment der Substantia gelatinosa Rolando der spinalen Quintuswurzel, und zwar entsprechend der Höhe der kaudalen Zweidrittel der unteren Olive. Suzuki meint, dass diese eigenartige Bildung als Endstätte der Lingualisfasern des N. trigeminus gelte, die zu den weit auf der Vorderzunge verbreiteten Geschmacksendapparaten bei diesem Tiere in Beziehung stehen. T. Ogawa.

447. Über die Entwicklung der perilymphatischen Räume im Gehörorgan der Anuren. Hideo SHIOBARA. [Hokuetsu Igk. Z., Niigata, 51 (1936), 1107-1138.] — Ausführliche Beobachtung über den Entwicklungsmodus des Saccus und Ductus perilymphaticus, des Spatium sacculare, der Pars communicans des letzteren, des Spatium naviculare, des Recessus fenestrae ovalis etc. im Gehörorgan von *Polypedates buergeri* Schlegel. T. Ogawa.

448. Über die Macula acustica neglecta der Amphibien, der Säugetiere und des Menschen. Hideo SHIOBARA. [Hokuetsu Igk. Z., Niigata, 51 (1936), 1038-1053.] — Verfasser studierte die Macula neglecta in *Polypedates buergeri* Schlegel, *Pseudosalamander kimurai* *Vesperugo abramus*, *Sus scrofa*, *Mus musculus* var. *alba*, *Homo sapiens*, zum Teil nach Rekonstruktion der Plattenmodellen. Die Macula neglecta der Amphibien entspricht strukturell nicht der Crista sondern der Macula acustica. In Embryonen von *Mus musculus* var. *alba* sind die Macula neglecta Sarasini und Macula neglecta Retzii co-existent. Die Macula neglecta der Säugetiere differenziert sich, wie bei Amphibien, aus der Macula partis inferioris. T. Ogawa.

449. Mikrochemie des Lipoides in den Leukozyten. (Japanisch.) Yasuhiko HAMAI. [Mitt. med. Akad. Kyoto, 17(1936), 596-614, 668, 1 Taf.] — Untersucht wurden die Leukozyten der Leiche, des gesunden Menschen und der Tiere (Kaninchen, Meerschweinchen, Ratte, Hund, Taube, Huhn, Frosche und Kröte.) In den polynukleären granulierten Leukozyten ist im normalen

Zustande reichliches Lipoid mit Sudan III nachweisbar. Das Lipoid nimmt seinen Sitz in den Granula und ist wenig widerstandfähig gegen den Aether und besonders gegen die Säuren (pH über 2,2.) Es lässt sich nur mit Sudan III färben und besitzt keine doppelbrechende Eigenschaft. Der Verfasser nimmt an, dass das Lipoid zum ungesättigten Phosphatide gehöre und mit der Substanz identisch sei, welche die Oxydase- und Peroxydasereaktion aufweist. T. Fujita.

450. Über die Struktur der Samenfäden einigen Urodelen. (Japanisch.) Katsumi MORI. [Nagasaki Igk. Z., **14** (1936), 125–132 mit 1 Taf.] — Die Samenfäden des *Hynobius nebulosus*, der *Pseudosalamandra kimurai*, des *Megalobatrachus japonicus* und des *Diemyctylus pyrhogaster* wurden mit verschiedenen Färbemethoden und auch an Querschnitten strukturell untersuchtt. Nebenbei wurde die Länge der einzelnen Abschnitte der Samenfäden statistisch gemessen. T. Fujita.

451. Studies on the Morphological Distribution of Glycogen in the Egg and the Tadpole of Frog. II. Report. The Stage from the Yolk Nutrition to the Oral Feeding. (Japanese.) Shimpei MIYAJIMA. [Seiikai Z., **55** (1936), 1185–1206. 16 Tab. 1 Pl.] — The glycogen was found chiefly in white substance of the brain and the spinal cord, heart muscles, epithelial cells of the gastrointestinal tube, liver, pronephros or head kidney, epidermis, sucker or cement organ, optic cup, cartilage cells and skeletal muscles. The glycogen came to appearance generally as fine granules or droplets. It was, however, distributed quite diffusely in the pharyngeal region, the inner gills, and the sucker. There was no marked difference in glycogen content between the organisms in the stages of yolk and oral nutrition. The distribution pattern of the glycogen in tadpoles was almost coincident with that of mature frogs. T. Fujita.

452. Studies on the Morphological Distribution of Glycogen in the Egg and the Tadpole of Frog. III. Report. The Stage of Metamorphosis. (Japanese.) Shimpei MIYAJIMA. [Seiikai Z., **55** (1936), 1576–1600. 16 tab. and 2 pl.] — The distribution of glycogen was almost the same as that in the tadpole. It seams therefore that the distribution of glycogen is little influenced by the metamorphosis or becoming carnivorous. The glycogen is mainly consumed for the formative activity in the stage of tadpole and for the formative and functional use in the later stages. T. Fujita.

453. Untersuchungen über die Wachstumsgeschwindigkeit der Schneidezahne des Kaninchens. (Japanisch.) Tadayosi NISIZUKA. [Nihon Shika Gk. Z., **29** (1936), 533–540. 3 Tab. 1 Taf.] — Die Schneidezähne des Kaninchens wachsen schneller bei der Resektion der Antagonisten. Die unteren Schneidezähne wuchsen nämlich 12,3 mm in 25 Tagen (ca. 2 mal so viel als im normalen Zustand) und die oberen 8,70 mm in 15 Tagen (ca 1,5 mal des normalen Wachstums). T. Fujita.

454. Untersuchungen über das Blut der Giraffe. (Japanisch.) Takaatu TAKAHASI, Raiziro TAKAHASI u. Naniti YAMAMOTO. [Rikugun Jûi. Hô, **318** (1936), 1–23, 5 Tab.] — I) Rote Blutzellen: abgeplattet oval (2,8 bis 3.5 μ, 5,6 bis 6,3 μ). 9–13,7 Milionen bei Männchen und 6–9,28 Milionen bei Weibchen. Senkungsgeschwindigkeit sehr klein. II) Weisse Blutzellen: normalerweise 1 auf 50 Erythrozyten, neutrophile polynukleäre Leukozyten 60%, Lymphozyten 37,67%, eosinophile Leukozyten 1,5% und grosse Monozyten samt Übergangsformen 1,34%. III) Widerstand der Erythrozyten. IV) Gesamte Blutmenge. V) Menge des Blutfarbstoffes. VI) Spezifisches Gewicht. VII) pH. IX) Osmotischer Druck. X) Chemische Bestandteile. XI) Vergleichung mit dem Blute der anderen Ungulaten. T. Fujita.

455. Ein Fall des Zahnmangels in der unteren Schneidezahngebiet nebst der erblichen Belastung für denselben. (Japanisch.) Yosiatu TOYOSIMA. [Nihon Shika Gk. Z., **29** (1936), 584–590. 4 Taf.] — An dem Unterkiefer eines 23 jährigen Mannes wurde das Fehlen der beiden mittleren Schneidezähne aufgefunden. An Stelle der fehlenden Zähne blieben die Milchschneidezähne stehen. Durch die Untersuchung der familiären Verhältnisse wurde festgestellt, dass die ähnliche Anomalie bei der Mutter und dem Bruder des Patienten vorhanden ist. T. Fujita.

456. **On the lobus electricus and the nervi electrici in *Narke japonica*.** Naokichi SUZUKI. [Manshû Ig. Z., 25(1936), 1-12, 15 figs.] — The anastomosis of the axis-cylinder process or the interneuronal connection of the ganglion cells can well be observed in the lobus electricus of *Narke japonica*. The ganglion cells have not only the fibrilar appearance in their ground substance, but also the granular element may concentrally distributed around the nucleus, except the hillock of the axis-cylinder process. The nervi electrici which issue on the ventral side of the lobus electricus consist chiefly of bour fundles. The branches of the first electric nerve run laterally to the nucleus trigeminus mot. ant. passing through the nucl. facialis sens., being mixed with the fibres of the tractus cerebello-motorius cruciatus. The other branch separated from the second electric nerve run ventromedially. One part of this bundle reaches the nucl. glossophar. et vagus, while the other enters the fasciculus longit. post., passing through the above mentioned nucleus. The scattered fibres which emerge from the posterior half area of the lobus electricus run ventromedially and pass along the dorsomedial rand of the fasc. longit. post. and intersect with the controlateral fibres in the raphe. T. Fujita.

457. **Über den Bau und die jahreszyklischen Veränderungen der Brunstschwiele bei der japanischen Kröte (*Bufo formosus*).** (Japanisch.) Minoru NAKASHIMA. [Kaibô. Z., 8 (1936), 1177-1209.] — Die Brunstschwiele von *B. f.* kommt am 1-4 Finger konstant vor und besteht aus vielen „Schwielenkegelchen", eigentümlichen Verdickungen der Epidermis, deren Oberfläche mit zahlreichen „Widerhäcken" versehen ist. An der Epidermis wird 2 Schichten unterschieden: hypertrophierte Epidermisschicht und spezifische Hornschicht. Die „Häckenzelle" weist anfangs eine kubische Form auf, wandelt sich später durch Apposition der Hornsubstanz von der unterliegenden Epidermisschicht zum eigentümlichen „Widerhäkchen" um. Die Schwiele zeigt am Ende März oder am Anfang April die höchste Entfaltung, im Frühsommer die schwächste Entwicklung. Die Regeneration beginnt schon im Spätsommer und geht in der Winterschlafzeit lebhaft vor sich. S. Nishi.

458. **Ein Junges Menschenei (Ei-Andô).** Keiichi HIRAMATSU. [Fol. Anat. Jap., 16 (1936), 15-45, 7 Taf.] - Das erste in Japan gefundenes jüngste Menschenei, dessen Alter vermutlich 14-15 Tage beträgt. In der Embryonalanlage sind die Ekto- und die Entodermblase unterscheidbar; der Embryonalschild mit einer Grösse von 0.24 : 0.26 : 0.04 mm bildet noch nicht den Primitivstreifen und die -rinne, die Entodermblase noch die Allantoisbucht. Hinsichtlich der Herkunft der Syncytiumzellen nimmt Verf. ihre Abstammung von Cytotrophoblasten an; Der Verschlusspflopf ist nicht die Gerinnungsmasse sondern die nekrotisierte Masse der zum Verschluss der Eingangspforte hyperplasierten primären Decidua capsularis. S. Nishi.

459. **On the Behaviour of Catfish in Response to Galvanic Stimuli.** Seiji KOKUBO. [Sci. Rep. Tôhoku Imp. Univ., Ser. IV (Biol.), 9, Nos. 2 & 3, (1934), 87-96. 2 figs.]

460. **The Duration of Life of Earthworms in Water and in Pure Gases.** Tametake NAGANO. [Sci. Rep. Tôhoku Imp. Univ., Ser. IV (Biol.), 9, Nos. 2 & 3 (1934), 97-109. 4 figs.] — The author aims to find the cause of death of earthworms that are found dead on the ground especially frequently after rains. The experiments were carried out with tap water, distilled water, humus extracts, pure nitrogen and carbon dioxide of various concentrations dissolved in the mediums just mentioned. The pH of the medium was also determined in the latter case. The earthworms can live for months in the glass vessels circulated with running tap water. The viability of the animal varies with the species. The duration of life in pure nitrogen and carbon dioxide was determined. The lack of oxygen and excess of carbon dioxide seem to be responsible for the death of the animal; that is, osmotic and other relations are not emphasized, as often are according to other authors. S. Nomura.

461. **On the Ganglion Cells in the Heart of the Pearl Oyster: *Princtada Martensi* Dunker.** Senji SUZUKI. [Sci. Rep. Tôhoku Imp. Univ., Ser. IV (Biol.), 9, Nos. 2 & 3 (1934), 111-115. 3 figs.] — The author previously described the distribution of ganglion cells in the heart of the oyster (the same journal, vol. 8, no. 4), and in this paper he also reports similar results of the study. The gross anatomy of the pericardium, the visceral ganglia and the heart of *Pinctada matensi* is given. A branch of the cerebrovisceral connectives, originating near the

visceral ganglia, runs towards the pericardium and innervates the visceral mass after passing the base of the auricles. But, penetrations of these nerve fibres into the heart could not be demonstrated in examing the serial sections. All the heart muscles are non-striped. The existence and distribution of ganglion cells in the heart were described. Nerve fibres in the auricles were observed by vital staining. The histological feature of these nerve fibres was almost the same as that of the common oyster. S Nomura.

462. On the Innervation of the Heart of Limpets. Senji SUZUKI. [Sci. Rep. Tôhoku Imp. Univ., Ser. IV (Biol.), **9**, Nos. **2** & **3** (1934), 117-121. 2 figs.] - The visceral ganglion consists of nerve fibres and ganglion cell which are unipolar or bipolar. The heart consists of three parts: auricle, ventricle and intra-pericardial aortic bulb. The heart is innervated by two branches of the visceral nerve, one of which enters the auricle and is distributed to both the auricle and the ventricle, while the other enters the aortic bulb and innervates the aortic bulb, aorta and the ventricle. The existence of ganglion cells in the heart was ascertained and their distribution was examined. Ganglion cells are more abundant in the other parts of the heart. S. Nomura.

463. Über die Exogastrulabildung beim Seeigelkeim durch Auxin, Glykogen und $KClO_3$. Isao MOTOMURA. [Sci. Rep. Tôhoku Imp. Univ., Ser. IV (Biol.), **9**, 2 & 3 (1934), 123-130. 4 Figs.] - The effect of auxin, glycogen, glucose and $KClO_3$ on the fertilized eggs of *Strongylocentrotus pulcherrimus* was studied. Auxin solutions produced exogastrula, while glycogen solutions mostly produced exoentogastrula. Exogastrulation can also be caused by addition of $KClO_3$ to Herbst's artificial sea water. Glucose has no such an effect. S. Nomura.

464. Ganglion Cells in the Heart of *Ligia exotica* (Roux). Senji SUZUKI. [Sci. Rep. Tôhoku Imp. Univ., Ser. IV (Biol.), **9**, Nos. 2 & 3 (1934), 213-217. 4 Figs.] - The gross anatomy of the abdominal ganglion and the heart is given. A nerve fibre bundle which runs along the dorso-median line of the heart contains six ganglion cells. These are multipolar. Two pairs of nerve fibres enter the heart on the mid-dorsal wall of the heart. The first pair of them contains two nerve cells near the heart, while the second pair contains only one cell in each fibre. S. Nomura.

465. Report on the Fresh-Water Sponges Obtained from Hokkaido. Nobuo SASAKI [Sci. Rep. Tôhoku Imp. Univ., Ser. IV (Biol.), **9**, Nos. 2 & 3 (1934), 219-247. 4 pls. & 15 figs.] — The author describes eight species of fresh-water sponges collected in his trip to Hokkaido in 1933. Two of the species are new. The list of species runs as follows: 1. *Spongilla lacustris* (Linné). 2. *Spongilla shikaribensis*, n. sp. 3. *Spongilla fragilis* Leidy. 4. *Spongilla akanensis*, n. sp. 5. *Ephydatia fluviatilis* (Linné). 6. *Ephydatia mülleri* (Lieberkühn). 7. *Epydatia mülleri* var. *japonica* (Hilgendorf). 8. *Heteromeyenia baileyi* var. *petri* (Lauterborn). S. Nomura.

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